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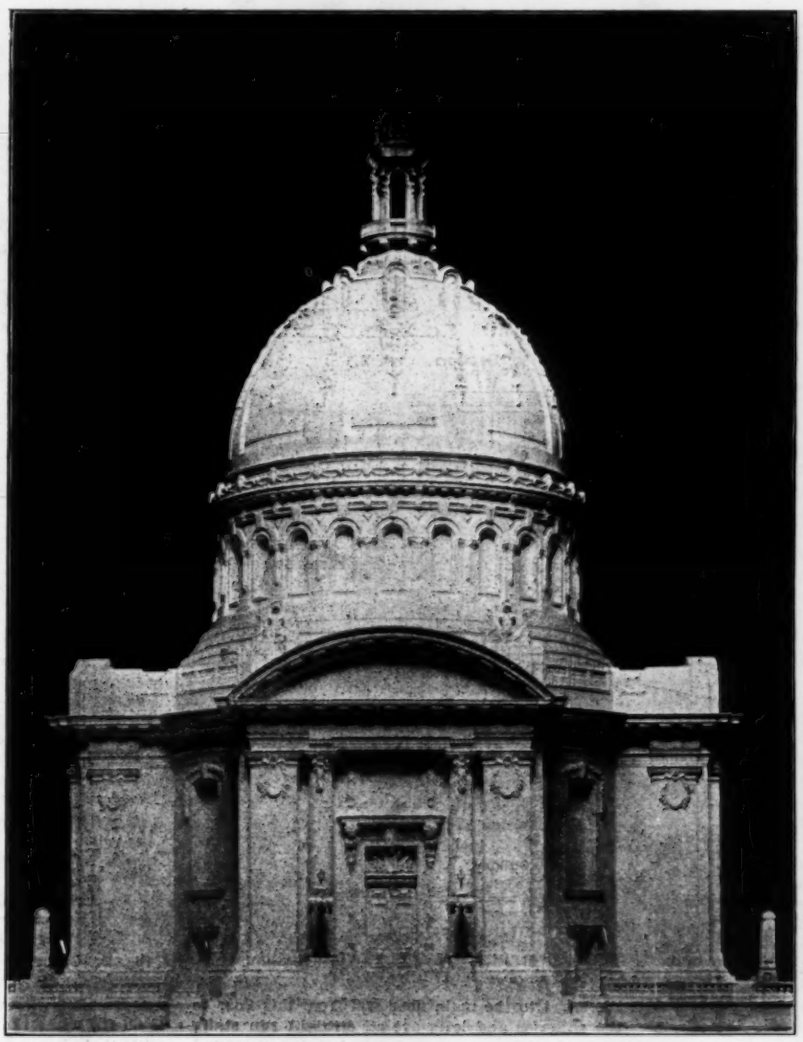
REINFORCED CONCRETE CHAPEL BUILDING, U. S. NAVAL ACADEMY, ANNAPOLIS, MD.

A notable example of the bold use of reinforced concrete is furnished by the new chapel building now being built for the U. S. Naval Academy at Annapolis. A view of this building is shown by our front page picture. As will be seen, it consists of a circular structure flanked by four wings 90° apart, and surmounted by a lofty dome and cupola. The dome shells, the arched roofs of the wings, the supporting piers and columns, the interior bracing, and the floors and their supports are all reinforced concrete. This concrete skeleton is, however, completely concealed by a covering of granite, white brick, and terra cotta masonry on the outside, and, on the inside, by the interior finish and decoration. The present description covers the reinforced concrete work.

GENERAL DESCRIPTION. — The structural features of the Naval Academy chapel are indicated by the drawings of Fig. 1. As will be seen the main supports of the building are eight piers arranged in pairs 90° apart around the periphery of a circle 83 ft. 4 ins. in diameter. These columns are vertical to a height of 35 ft., then they corbel radially inward until the distance between inside faces of diametrically opposite columns is reduced from 83 ft. 4 ins. to 72 ft. 10 ins. The corbelled tops of the columns are surmounted and connected by a circular girder, which is a ring cut from a hollow cone and has an inside diameter at the bottom of 72 ft. 10 ins. and at the top of 69 ft. 8 ins. On top of this circular girder are spaced 24 columns, which corbel inward like the main piers and carry a second circular girder similar to the first. This last girder carries the shells forming the main dome and the ceiling dome. The lantern is carried by a pyramidal framework, whose spreading legs set into the main dome shell near its bottom. There is also a system of struts between the piers, as indicated by the drawings of Fig. 1.



GENERAL VIEW OF PLASTER MODEL OF NEW NAVAL ACADEMY CHAPEL AT ANNAPOLIS, MD.

The four wings of the building form transepts to the main auditorium, and each is roofed by a segmental arch, supported at its four corners by the main piers and by two separate columns. As these roof arches carry no load except their roof covering, the thrust on the columns is readily taken up by a tie across the front of the arch. The drawings of Fig. 1 show this arrangement clearly. The remaining structural framework of the building, all of which is of reinforced concrete, comprises the main and gallery floors, and is clearly indicated by the same drawings.

PIERS AND FOUNDATIONS.—It will readily be seen from the preceding general description that the main problem in the design was due to the fact that the dome, being of smaller diameter than the circular main structure, had to be carried in cantilever over its supports. The construction of the main piers to meet this condition is shown by Fig. 2. As stated above, the piers are rectangular and vertical to a height of 55 ft. above the footings and then corbel radially inward toward the center of the building. Fig. 2 shows the upper or corbelled portion of one pier. The eccentricity of the loading due to the corbelling made it necessary to reinforce the outer face of the column to take tension and the inner face to take compression. The drawings show the connection used to make the tension bars continuous; the compression bars had butt joints enclosed in steel sleeves. All the vertical bars were tied together at intervals by horizontal peripheral hoops of ¼-in. rods. Details of the reinforcement of the corbelled portion are given in Fig. 2, and it is to be noticed that the top of the column is anchored into the circular girder. The piers are founded on concrete footings, 13½ × 16½ ft. in plan, which bring a load of about four tons per square foot on the soil.

CIRCULAR GIRDER. —The architect's plan required the dome to be carried on 24 columns. To connect these columns with the supporting piers the tops of the latter were bridged by a circular girder, on which the dome columns took footing. A half plan and diametrical vertical section of this girder are shown in Fig. 3. Fig. 4 shows radial sections of the girder at two points. It will be noticed that the girder is corbelled inward and carries a gallery in cantilever. The attachment of the column tops to the girder was shown in Fig. 2. These eight points of support alone, however, left a considerable span of girder unsupported, as shown by the plan Fig. 3, and braces were therefore introduced, reaching diagonally from the piers to the girder. The thrust of these brackets against the piers was transmitted to the companion piers of each pair by a horizontal strut, and it is important to note the interlocking

of the strut and brace reinforcement, and the bonding of the brace reinforcement into the girder.

DOME COLUMNS AND RING.—The 24 columns supporting the dome take footing at equidistant intervals around the circular girder, and are bonded into this girder by their reinforcement, as shown by Fig. 4. These columns are corbelled inward like the main piers and carry a circular ring, on which the shells of the dome rest. The drawings of Fig. 5 show the details of the columns and the dome ring. It will be noticed here also that the columns are bonded into the dome ring in much the same way that the main piers are bonded into the large circular girder.

DOME SHELLS.—The dome proper of the building, as shown by Fig. 1, consists of two shells,

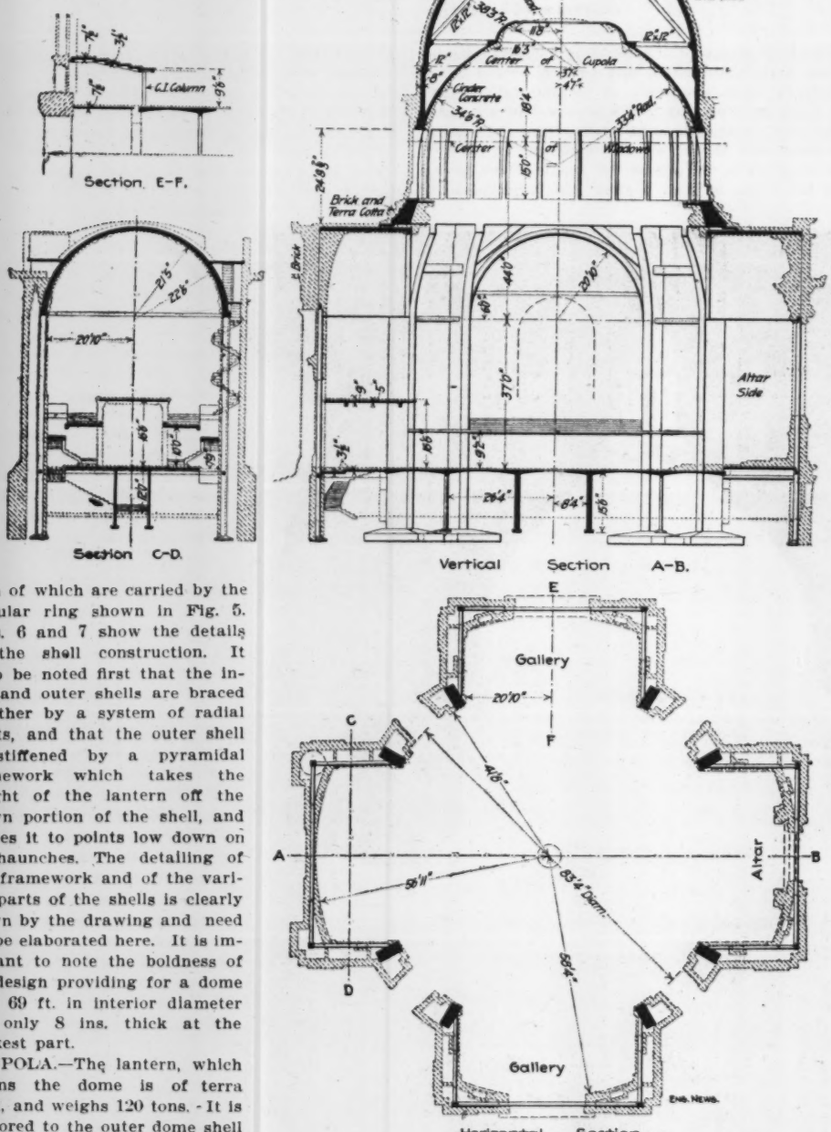


FIG. 1. SECTIONAL PLAN AND ELEVATIONS OF NAVAL ACADEMY CHAPEL.

both of which are carried by the circular ring shown in Fig. 5. Figs. 6 and 7 show the details of the shell construction. It is to be noted first that the inner and outer shells are braced together by a system of radial struts, and that the outer shell is stiffened by a pyramidal framework which takes the weight of the lantern off the crown portion of the shell, and carries it to points low down on the haunches. The detailing of this framework and of the various parts of the shells is clearly shown by the drawing and need not be elaborated here. It is important to note the boldness of the design providing for a dome shell 69 ft. in interior diameter and only 8 ins. thick at the thickest part.

CUPOLA.—The lantern, which crowns the dome is of terra cotta, and weighs 120 tons. It is anchored to the outer dome shell to resist wind strains, but its weight is relieved from the shell by the pyramidal framework previously mentioned. It was impracticable to make the shell strong enough to carry the cupola because of the series of skylight openings at the crown.

WINGS.—The only parts of the wings that call for attention are the roof arches and their supports. The arches are semi-circular segments, with a clear span of 42 ft. 10 ins., a crown thickness of 8 ins., and a thickness at skewbacks of 14 ins. This circular shell connects into the main piers at its inner end and is carried on two columns at its outer end, as clearly shown by the view Fig. 8. To prevent these isolated columns from spreading under the arch thrust, a tie is carried across the arch at this point. The columns are rectangular with a vertical bar at each corner, and hoops connecting these bars at small intervals vertically.

FLOORS AND STAIRWAYS.—The main floor of the chapel is composed of thin flat-top concrete arches carried by the main piers, a circular row of concrete posts and a circular concrete wall. This construction is clearing indicated by Fig. 1, which also shows clearly the gallery floors and those of the altar and organ loft. The stairways from the crypt to the main floor and from this floor to the galleries and lofts are all straight run stairs of reinforced concrete. A spiral stairway around one of the columns carrying the arch roof of the north wing and inclosed in the curtain walls, as shown by the plan Fig. 1, gives access to the roof. This stairway is also reinforced concrete.

GENERAL DISCUSSION.—To ensure clearness the preceding description has been held closely to a bare statement of the structural parts of the chapel as shown by the drawings. This description needs to be supplemented by further explanation of the conditions influencing the design and other general aspects of the work. It is important to explain at the outset that the original plans of the architect called for a solid concrete construction for the walls, and this concrete was to be faced with brick, granite, terra cotta, etc. Bids were asked on these plans, and when received were found to be above the amount appropriated for the chapel building. Contractors were then asked to propose designs of their own on the condition that the architectural lines of the building be respected. The Noel Construction Co., of Baltimore, Md., proposed a design, made by the Baltimore Ferro Concrete Co., and were awarded the contract. Compared with the original design for solid concrete walls, dome and roof arches, the new design first decreases the load by substituting reinforced concrete for the dome shells and roof arches, and then carries this load to the foundations by piers instead of by the building walls. This made it possible to enclose the building with hollow walls and thus materially cheapen the construction.

The substitution of the new design involved several structural difficulties. As has been noted

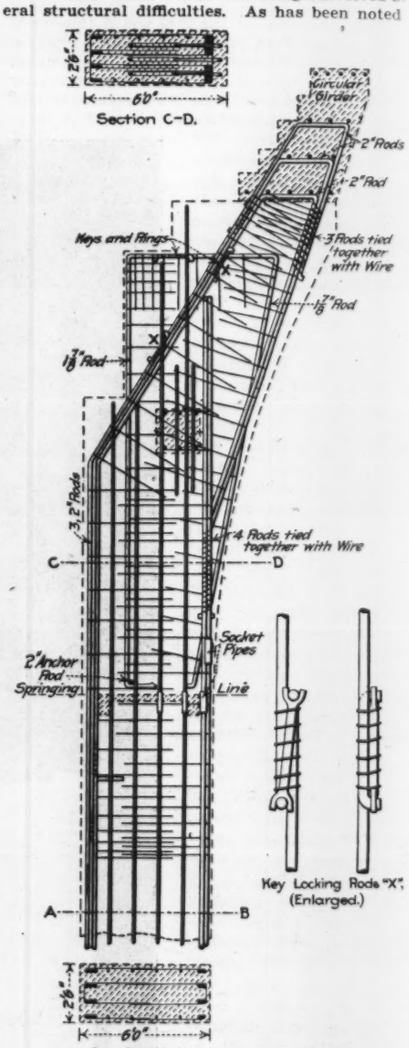


Fig. 2. Corbelled Top of Main Piers for Naval Academy Chapel.

in the preceding description the diameter of the dome is 69 ft., while the piers which support it are set with their inner faces on the circumference of a circle 83 ft. 4 ins. in diameter. The eccentricity of the dome shell with respect to its main supports is thus 7 ft. 2 ins., and this eccentricity had to be provided for by corbelling inward the whole structure supporting the dome, so that a cantilever construction was demanded in the main piers, the circular girder, and the dome columns. This explains the complexity of the reinforcement and the intimate bonding of the several connections that are shown by the drawings. In this last respect of the close bonding of the connec-

tion. This structure is quite unique among American examples of reinforced concrete work. It should be noted also that the reinforcement consists entirely of round rods. As giving some idea of the complexity of the reinforcement in places two views are given in Fig. 9 of the reinforcement for the large circular girder, and one in Fig. 10 of the reinforcement for one of the main pier footings.

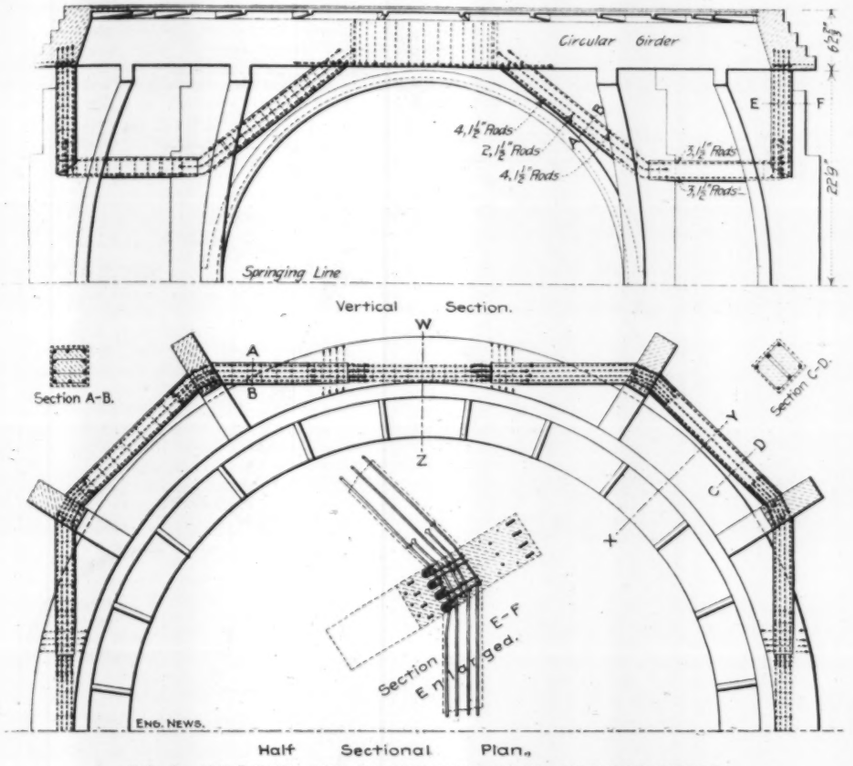


FIG. 3. HALF-PLAN AND HALF-ELEVATION OF CIRCULAR GIRDER.

The preceding drawings give some idea of the dimensions of the work. Measured from the ground level the chapel building is 64 ft. high to the top of the wings, 143 ft. 7 ins. high to the top of the dome, and 192 ft. 3 ins. high to the finial of the cupola. The main building has a clear inside diameter of 83 ft. 4 ins., and each of the four transepts is 41 ft. 8 ins. wide and 16 ft. 8 ins. deep. The height from the main floor to the top of the circular girder is 66 ft., and to the top of the ceiling dome is 110 ft. The dome is 69 ft. in diameter at the bottom. Exteriorly each wing has a width of 60 ft. 2 ins., and the total outside diameter of the building through the wings is 130 ft.

METHOD OF CONSTRUCTION.—The views Figs. 8 and 11 show the chapel building in course of erection. There was little that was unusual in the work until the roof arches and the dome shell came to be erected. Considering the outer dome shell first, it may be noted that the lower and practically cylindrical portion was constructed exactly as a circular tank would be. When the shell began to curve inward use was made of the mold shown by Fig. 13. This mold and its supporting frame was built upward as the word progressed, without support except the part of concrete erected before. The roof arches were built in a similar manner to the dome shell.

The building illustrated is a part of the new Naval Academy now being constructed at Annapolis, Md., by the United States Government at a cost of $15,000,000. The architect of the new Academy, and, therefore, of course, of the chapel building, is Mr. Ernest Flagg, of New York city. The contractors for the chapel are the Noel Construction Co., of Baltimore, Md., who sublet the design and construction of the reinforced concrete work to the Baltimore Ferro Concrete Co., of Baltimore, Md. We are indebted to the architect and to the contractors for the information from which this description has been prepared.

ANNUAL MEETING OF THE AMERICAN SOCIETY FOR TESTING MATERIALS AT ATLANTIC CITY, N. J.

(Concluded from p. 23, July 6, 1905.)

COMMITTEE ON PRESERVATIVE COATINGS FOR IRON AND STEEL.—A subject markedly different from most of the other phases of testing came before the meeting in the report of its Committee E, on Preservative Coatings for Iron and Steel, and in several papers which were presented at the same session as the report. The committee, it should be said, avowedly restricts its studies to the determination of standard methods for testing the efficiency of paints and other preservative coatings, and does not intend to study the value of different kinds of paint. In pursuit of its general purpose, however, a study of different paints in actual service and under several different forms of test will become necessary. Several sub-committees have been at work to fix upon procedure for conducting such comparison tests. A sub-committee on Permeability of Paint Films, another on Permanence of Paint Films, and a third on Preparation of Iron and Steel Surfaces for Painting, have been at work. The results hitherto reached are small, and not of sufficient general interest to warrant report here. Exception may be made with regard to a method developed by Mr. G. W. Thompson (Brooklyn, N. Y.) for securing paint films for study. The paint is brushed on a thoroughly amalgamated tin plate, and when dry may be removed intact by rolling up on a rod. Mr. Thompson showed at the meeting a collection of films produced in this way, all of which were excellently uniform in thickness and texture; some of the films possessed a surprising degree of strength and elasticity.

Mr. Thompson also read a paper, following the committee's report, under the title "Proper Methods in Conducting Painting Tests." In this paper he emphasized the importance, in making comparative painting (exposure) tests, of recording definitely all the elements concerned, especially formula of mixing, and spreading rate per gallon (as computed from weight used for a given area covered). A procedure for testing covering power is also described.

An address on "Paints and Painting" was given by Mr. Maximilian Toch (New York, N. Y.), which was illustrated by a large number of lantern views showing paint conditions.

Mr. F. P. Cheesman (New York, N. Y.) presented a paper on the subject "What is the Best Method of Painting Steel Cars?" The main features recommended are: (1) The use of but a single coat if conditions at the shops are such that time cannot be allowed for the first coat to dry before a second is applied; (2) the elimination of red lead from steel car painting and the substitution of blue lead for the bottom coat. Blue lead, as was explained by Mr. S. M. Evans (New York, N. Y.), is the result of the sublimation of lead ore (galena), and consists of part sulphate, part sulphide of lead; it contains practically no carbon. Slight oxidation of the material takes place in course of time, as shown by a slight darkening. The substance resists sulphur dioxide gases perfectly, but, like all lead compounds, yields under exposure to sulphuretted hydrogen.

A new method of protecting steel structures against corrosion was described by Mr. Louis H. Barker (Jersey City, N. J.) in a paper "Protection of Iron and Steel Structures by Means of Paper and Paint." The method bases on the idea that moisture must be kept away from the metal. The metal is painted with a coat of paint of special composition, and immediately upon this, while yet sticky, is placed paraffined paper, the sheets being applied with edges lapped, so that no crevice remains through which moisture could pass. A first coat of paint is then applied over the paper as soon as the latter is placed, and when this coat is dry a second coat is given. This method was developed in the endeavor to stop corrosion in the Pennsylvania R. R.'s large train-shed at Jersey City, N. J. Very severe exposure tests, some of them having lasted now for over two years, show that the method gives, practically, absolute protection, even in smoke and gases (when not so hot as to burn the paper) and in sewer air.

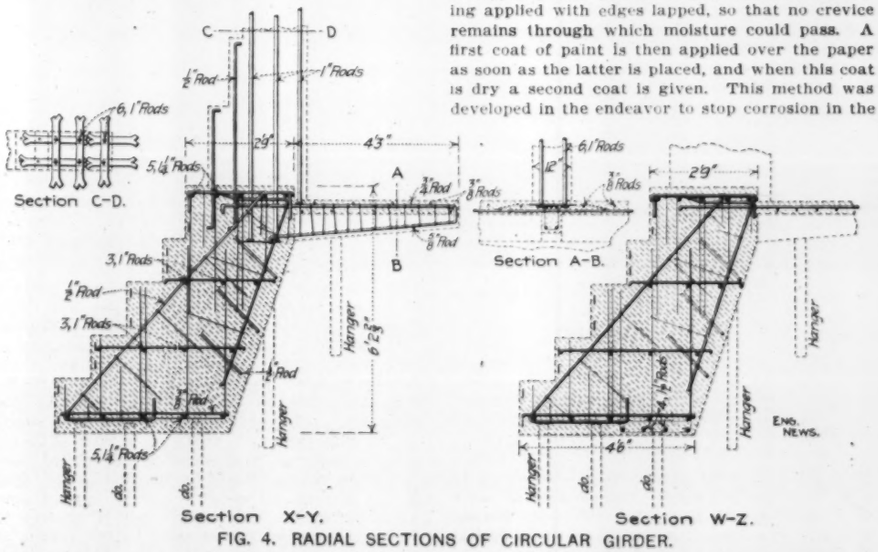


FIG. 4. RADIAL SECTIONS OF CIRCULAR GIRDER.

A further paper was presented by Mr. J. C. Blanch (New York, N. Y.), dealing with the relation of electrolytic corrosion to the life of paints.

The subject of paints and painting, introduced by the above-mentioned reports and papers, was discussed at some length. Mr. C. B. Dudley (Altoona, Pa.) remarked that slow drying of paint, generally considered beneficial, is not necessarily so, but that rather the use of poor driers is responsible for the bad results with rapid-drying paints. A comparative test on boards painted, one with a paint drying in 12 hrs., the other with the same paint mixed so as to dry in 2 hrs. showed that the difference in condition after three years' severe exposure was vanishingly small. The drier used in the rapid-drying paint had been carefully chosen. Mr. M. Toch (New York, N. Y.) suggested that an ideal drier should be a siccative which will stop its oxidizing action when the paint film is dry. Mr. G. W. Thompson (Brooklyn, N. Y.), in exhibiting the paint films prepared by his special procedure already noted, expressed the opinion that the blistering of paint films indicates that they are non-porous. The committee's report included some microscope observations on paint films, made with a view to detecting porosity, with negative (but not conclusive) results. Some of the experience with paints in the New York Subway was recited by Mr. C. De Wyrall. Originally it had been thought that linseed oil paints should not be used in the subway, but after a comparative test of about a hundred different paints, linseed oil paint was adopted. Materials were bought under rigid test, and the work was done as thoroughly as the conditions (particularly with regard to moisture) allowed. The paint began to fail within a year, the corrosion going on unnoticed under the paint until it broke through in fine pustules and finally caused incipient flaking off of the paint. After careful investigation it was concluded that the great humidity of the subway atmosphere supplied enough moisture to saponify the linseed oil, and so transferred enough moisture behind the paint for corrosion. The paint now used is one which will dry free from dust in 10 minutes, and is dry enough to lean against in 40 minutes; it contains no linseed oil.

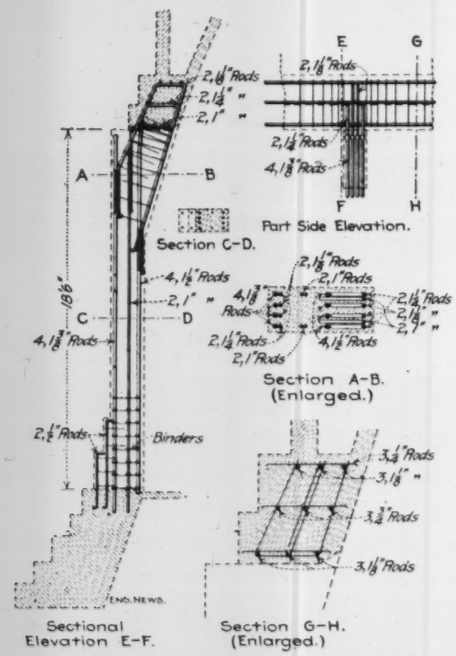


Fig. 5. Details of Dome Columns and Ring.

This has now been in use for over two years, with very good results. Comparison of steelwork painted with this paint, and work painted with linseed oil paint, shows that, after a change of atmosphere outside, the former is dripping wet with condensation in two or three hours, whereas the linseed-oil work does not show moisture for 12 hours later. This indicates that the linseed oil coat absorbs large quantities of condensation moisture until saturated. In the experience of the subway, laboratory tests on paints gave results quite opposed to the actual service; the paint that proved best had been rejected on laboratory tests, while the linseed oil paint had been accepted. This fact is held to speak strongly against the possibility of drawing up a single standard specification for paint at least in the near future. Mr. De Wyrall also mentioned that blue lead had been tried on the elevated structure in New York City, but had to be removed in seven months.

cited the practice of Mr. E. C. Shankland, w has applied this procedure to several bridges tall buildings, in support of his suggestion.

COMMITTEE ON STANDARD SPECIFI TIONS FOR IRON AND STEEL.—The deta and thorough report of this very important c mittee, and the lengthy consideration of the port, can be given but scant mention here cause of the nature of the subject discussed. committee presented certain specifications

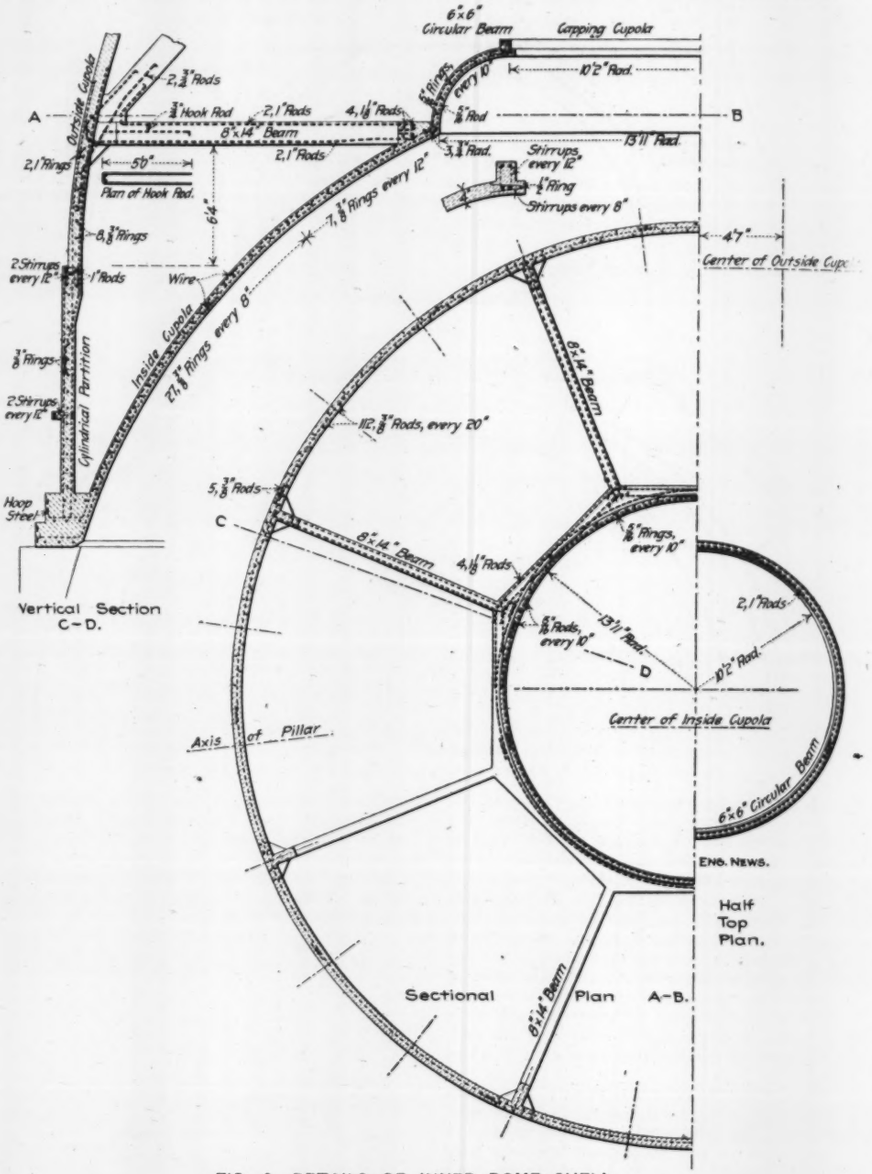


FIG. 6. DETAILS OF INNER DOME SHELL.

In concluding the discussion, Mr. Dudley called attention to the fact that when a gallon of paint is spread over 1,200 sq. ft., the film is less than 0.002 in. thick, even when wet. Requiring a film of this thickness to protect iron against corrosion is very severe duty, especially as many small air bubbles scattered in the film make the least thickness much smaller. He raised the question (for the present without answer) whether it is possible by any means to brush on a coat of paint without working in air-bubbles. A related consideration was mentioned by Mr. Richardson, that a coat of paint on metal is always applied over an absorbed film of moisture, which remains to do damage unless carried away by the vehicle of the paint. An evaporative vehicle, he suggested, possibly acts to carry away this moisture.

A letter from Mr. J. W. Whitehead, member of the sub-committee on Preparation of Surface, advocated for consideration the procedure of erecting steelwork unpainted, and allowing the scale to loosen by rusting before paint is applied. He

adoption, and recommended specified changes in others. The action taken by the society in the individual matters is summarized in the following:

STRUCTURAL STEEL FOR SHIPS.—The former standard specifications for structural steel for bridges and ships were recommended to be restricted to ship material, by omitting the words "Bridges and." The recommendation was accepted for submission to letter-ballot.

STRUCTURAL STEEL FOR BRIDGES.—It was recommended that the American Railway Engineering and Maintenance-of-Way Association's "Specifications for Material for Steel Structures" adopted by the Association in 1904, be adopted by the Society under the title "Standard Specifications for Structural Steel for Bridges." Two changes were, however, recommended: In the clause providing for retest of tensile specimens if the first test varies by more than 4,000 lbs. from the desired 60,000 (50,000 for rivet steel), the retest to come within 5,000 lbs. of the desired

figure the committee recommended that the retest be permissive instead of prescribed. This led to long discussion, Mr. J. P. Snow (Boston, Mass.), for the Association, being strongest in opposition to the change; he desired either a positive retest or to have a range of 8,000 lbs. in place of 10,000. Finally, however, the Society voted to retain the permissive wording, adding that the retest may be made "at the option of the inspector." Three other changes were advocated by Mr. Snow: (1) The prescription, in the cold-bend test for steel castings, that the 90° bend shall be around a diameter three times the thickness of specimen; (2) the provision of reduced elongation for very thin and very thick pieces, the omission of the clause for steel castings, on the ground that no elongation test is specified for such material; and (3) the omission of the weight-tolerance table for plates under ¼ in. thick. The first two changes were accepted, the third rejected, and the whole specification was passed to letter-ballot.

OPEN-HEARTH BOILER PLATE AND RIVET STEEL.—Certain changes in this (standard) specification, proposed by the American Society of Mechanical Engineers, were rejected, and the standard specification is therefore left unchanged. A feature of the discussion, in view of the fact that one change proposed was to reduce the specified strength of firebox steel by 2,000 lbs., was the advocacy of higher steel for boiler work, by Mr. C. B. Dudley (Altoona, Pa.) and Mr. William Metcalf (Braeburn, Pa.).

STEEL RAILS.—This report led to animated discussion. The subjects of sound and unsound rails, piping, segregation, etc., developed some uncertainty and much difference of opinion.

Primarily, the committee recommended the adoption of the American Railway Engineering and Maintenance-of-Way Association's "Standard Specifications for Steel Rails" (based originally on the Society's specifications), but proposed certain changes. It was the changes that caused all the discussion. It was proposed, in the clause requiring the drop-test piece to be taken "preferably from the top of the ingot," to omit the word "preferably," thus making the top-of-ingot test mandatory. This recommendation was accepted by the Society, as also (on motion of Mr. Albert Sauveur, of Boston) the insertion of a top-of-ingot requirement in the clause governing retests in case the first drop-test piece fails.

But correlated in tendency with this top-of-ingot provision is the clause which requires a drop-test from each blow of steel, and here the committee desired to substitute "every fifth blow." At the meeting, however, the advocates of rigid testing made a strong stand for testing each heat, on the ground that this is the only test which guards against unsoundness and should therefore be applied thoroughly. Mr. Robert Job (Reading, Pa.) particularly held out for the "every heat" provision; the Reading has tested every heat for five years past, and would consider it distinctly retrograde to go back to every fifth blow. Mr. C. P. Dudley (Altoona, Pa.) suggested that the increase in size of ingot has something to do with increasing unsoundness in the rails of recent years. He notes, further, that whenever a lot of new rails is put into service, some few rails come out of the track very soon, in from six weeks to three months; after that time the remaining rails will have a normal length of life, five or twenty years, as the case may be. This is observed even under the most rigid inspection and testing. Mr. H. H. Campbell (Steelton, Pa.) referred to the wide use of both light and heavy sections for electric trolley roads, where quality is not so essential, and expressed the view that it was wrong to establish standard rail on excessively high basis for general service; rather, he said, let heavy-traffic railways issue a special, more stringent specification, leaving the Society's specification available for general purposes. The result of much discussion of this nature was that the question of drop-testing every heat or every fifth heat was referred back to the committee for reconsideration, with power to take final action. Slightly reduced heights of drop in the drop-test, as recommended by the committee, were accepted.

The clause governing measurement of rail shrinkage from hot saws, a very important clause since it is intended to govern the temperature of the last pass of the rail, and thereby insure fine grain, is still in the hands of the commitee. The standard lengths of rail were recommended to be changed from 33 and 27 ft. to 30 and 24 ft. Accepted.

Adoption of the specifications as a whole will, of course, be by letter-ballot.

STEEL CASTINGS; STEEL AXLES; STEEL FORGINGS.—Certain changes proposed by the American Society of Mechanical Engineers were not accepted by the committee, and the action of the latter was approved by the Society. In the matter of the specifications for axles and forgings, the committee proposes to introduce separate clauses for locomotive axles and forgings, following the recommendations in this matter made by Mr. H. V. Wille a year ago as a compromise between the specifications of the Society and those of the American Railway Master Mechanics' Association. This proposal also was accepted by the Society.

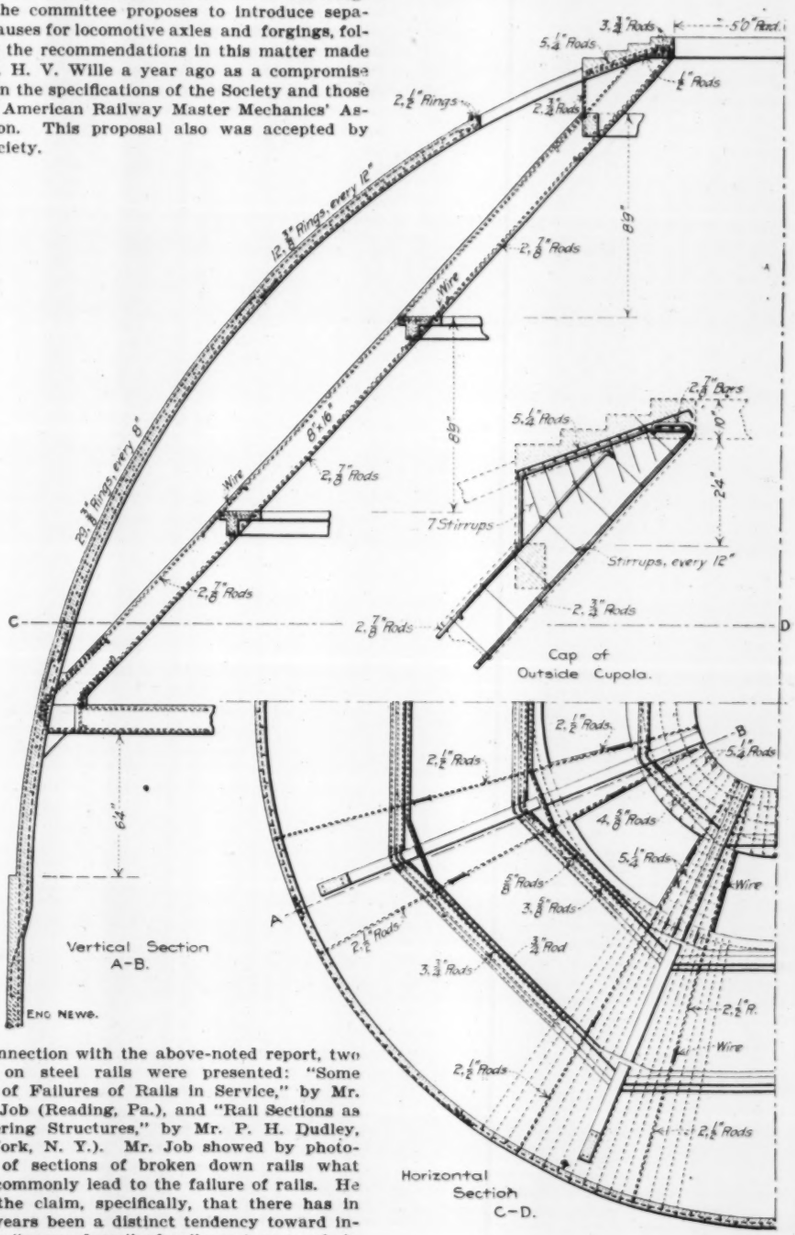


FIG. 7. DETAILS OF OUTER DOME SHELL AND CUPOLA SUPPORTS.

In connection with the above-noted report, two papers on steel rails were presented: "Some Causes of Failures of Rails in Service," by Mr. Robert Job (Reading, Pa.), and "Rail Sections as Engineering Structures," by Mr. P. H. Dudley, (New York, N. Y.). Mr. Job showed by photographs of sections of broken down rails what causes commonly lead to the failure of rails. He makes the claim, specifically, that there has in recent years been a distinct tendency toward increasing "unsoundness" of rails, not so much in the matter of piping as in blowholes.

COMMITTEE ON STANDARD SPECIFICATIONS FOR STAYBOLTS.—A specification was submitted, by Mr. H. V. Wille (Philadelphia, Pa.), chairman, but coupled with it was the request that the specification be held for a year, as tentative, leaving any action thereon until next year's meeting. This request was approved. The specification establishes not only tests, but also method of manufacture, describing in detail the arrangement of piling. The iron is then required to have a tensile strength of 48,000 lbs., with 28% elongation in 8 ins. and 45% reduction of area, must stand cold bending close in both directions without flaw, and lastly must stand a specified vibratory test. The report says, on the vibration test:

> It has not yet been proven that results can be duplicated in various machines, nor that the particular method employed in testing gives the most satisfactory results.

It is expected that wider experience with vibration tests will become available during the coming year. The discussion showed considerable disagreement with the specification proposed. Mr. Max Wickhorst (Aurora, Ill.) objected to specifying both the tests and the methods of manufacture, and suggested that possibly proper heat treatment might enable irons made by other than the specified method to pass satisfactory tests. He referred then to the great difficulty of holding the end of the bolt, in the vibration test, so rigidly as to prevent motion there, and attributed some of the erratic results of vibration tests to this cause. Mr. J. A. Kinkead (Schenectady, N. Y.) reported that in his experience the vibration test is extremely erratic, it being impossible to secure even roughly concordant results with a single piece of material.

In connection with the committee report, Mr. Wille presented a paper entitled "Influence of Methods of Piling Staybolt Iron on Vibratory Tests." The paper details comparative tests on staybolt iron made from blooms piled in different

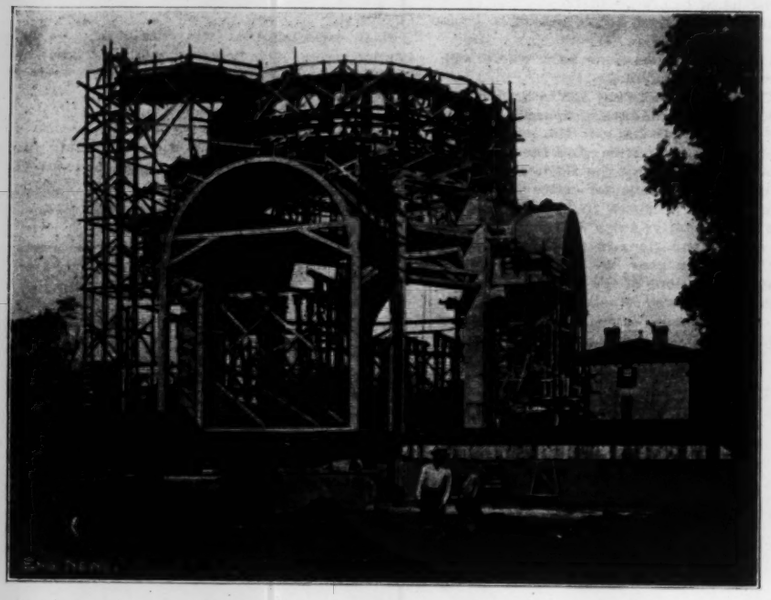


FIG. 8. VIEW OF CHAPEL DURING ERECTION, SHOWING ARCH ROOF COLUMNS.

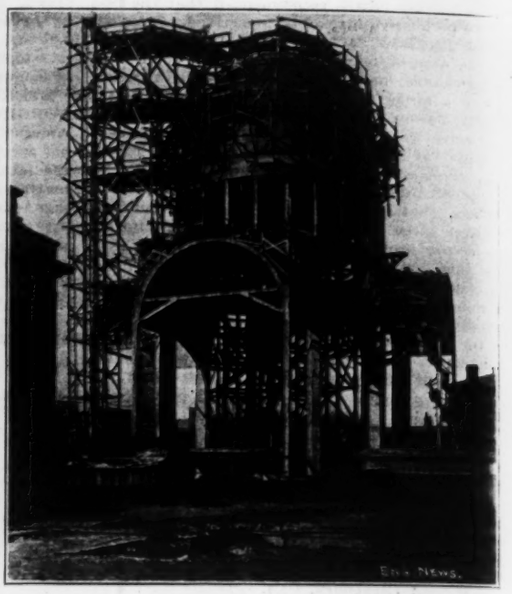


FIG. 11. VIEW OF CHAPEL UNDER CONSTRUCTION, SHOWING FALSEWORK.

arrangements and draws the conclusion that the method of piling in the specification is the best.

COMMITTEE ON CAST IRON AND FINISHED CASTINGS.—Two complete specifications were submitted by this committee, Mr. Walter Wood (Philadelphia, Pa.) chairman. These are: Standard Specifications for Cast Iron Car Wheels and Standard Specifications for Gray Iron Castings. Both were passed for letter-ballot. In the case of gray iron castings, however, Mr. William Kent (Syracuse, N. Y.) suggested that a certain range of testing speed be allowed in the transverse test, rather than specifying a definite speed. This suggestion was referred to the committee with power to act.

Mr. R. Moldenke (Watchung, N. J.) presented a paper, "A Comparison of Standard Methods of Testing Cast Iron," in which he reviewed the conditions in England and Continental Europe as regards standard requirements or specifications for both pig iron and castings. Mr. Henry Souther (Hartford, Conn.) read a brief paper entitled "Hard Cast Iron, the Theory of One of its Causes." The paper recites several cases where hard iron was complained of, or rather a "gritty" character of the iron in thick sections, while thin sections machined well. It was found that manganese was low in these castings, and that increasing the manganese to 0.5% removed the trouble. The author suggests that a carbide of iron or silicon may be formed in the absence of sufficient manganese. Mr. C. B. Dudley (Altoona, Pa.) suggested, as an alternative explanation, that oxygen may have been the source of the trouble; he is sure that oxygen is present and often is harmful in both cast-iron and steel, but has yet found no way to determine it.

Two further papers were presented at the session on Cast Iron, but these were of such character that only their titles are here recorded, "A Year's Laboratory Records of Pig Iron," by Mr. H. Buell, and "The Thermite Process in American Practice," by Mr. E. Stuetz (New York, N. Y.).

STANDARD TESTS OF ROAD MATERIALS.—Mr. L. W. Page (Washington, D. C.), chairman of this committee, presented a report recommending two tests as standards: an impact test of stone as a measure of its toughness, and a test for the determination of bitumen in asphalts. Both tests were accepted. The impact test is similar in its procedure for that used for testing cementing power of stone-dust, but 25-mm. blocks of stone are used in the present test and a round-ended 1-kg. die is used to transmit the impact to the block. Successive blows, each 1 cm. higher than the preceding, with a 2-kg. hammer, and beginning with 1 cm. fall, are used; the number of blows is to be taken as the index of toughness.

An interesting paper, related to the subject of this committee report, was read by Messrs. Clifford Richardson and C. N. Forrest (Long Island City, N. Y.) under the title "Impact Tests of Asphalt Paving Mixtures." Tests were made on asphalt surface mixtures by a test closely the same as that recommended by the committee for toughness of stone. Trinidad mixture was found to give about 29 blows (last blow 29-cm. high).

COMMITTEE ON BOILERS.—This commitee, whose function is to secure revision of the government steamboat inspection provisions relating to boilers, reported its work of the past year in detail. No definite progress has been made, in spite of repeated strenuous endeavors to impress upon the government authorities the need for revision.

The Committee on Magnetic Testing of Iron and Steel failed to submit a report, but expects to do so before publication of the Society's "Proceedings." A report of organization and planning of work was made by the Committee on Building Brick. A similar report was made by the Committe on Lubricants.

New committees will probably be established on Waterproofing Materials and on Scientific Study of Structural Steel.

The above summary of committee reports and associated papers does not include some interesting papers read at the meeting. At the session held jointly with the Society for the Promotion of Engineering Education, two education papers were presented: "A Course of Laboratory Instruction in Testing Materials," by Prof. W. K. Hatt (Lafayette, Ind.), and "A Course in Properties of Materials," by Prof. G. L. Christesen. Both papers outlined their respective courses in very full detail. At the session of the Cement Section, Mr. R. L. Humphrey (Philadelphia, Pa.) gave an illustrated address on "The Collective Portland Cement Exhibits and the Results of the Tests Made at the World's Fair, St. Louis, Mo."

"A Preliminary Report on Tests of Nickel Steel and Carbon Steel Under Combined Stresses," by Mr. E. L. Hancock (Lafayette, Ind.), presented material in a field of very great importance. We hope to present a full abstract of the paper at another time. Briefly, it summarizes tests made on bars (1) in tension while the bars were under

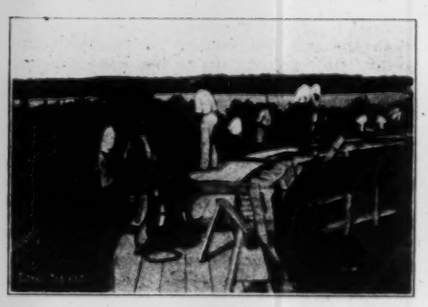


FIG. 9. VIEWS SHOWING REINFORCEMENT FOR CIRCULAR GIRDER.

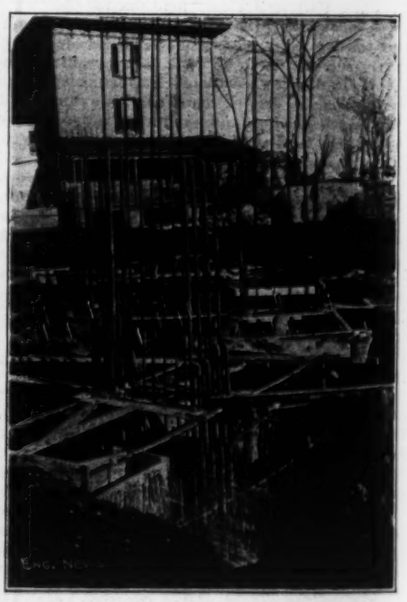


Fig. 10. View Showing Reinforcement for Pier Footing.

various definite torsional moments, and (2) in torsion while the bars were under various definite tensile stresses. Marked lowering of both strength and modulus were found.

Mr. R. D. De Wolff presented a paper on "Specifications for Cotton Tapes for Electrical Purposes," outlining the considerations on which the various strength and quality requirements of such a specification should be based.

Finally, an interesting form of testing machine was described in a paper by Mr. R. A. Cummings (Pittsburg, Pa.), entitled "A Large Hydraulic Testing Machine for Uniform Loads." The machine applies load by hydraulic plungers, but the distribution of loading is accomplished mainly by sets of equalizer bars. We expect to reprint this paper in another issue of Engineering News. It was remarked in discussion that similar test appliances have been used by Schüle in Zürich, Talbot at Urbana, and at the Massachusetts Institute of Technology. The Cummings machine was, however, developed wholly independently.

POSSIBILITIES IN HEATING WITH HOT AIR.*

By R. S. Thompson.

In heating with hot air, the air is heated by contact with hot surfaces in a central heating-apparatus, and is then conveyed to the rooms. In heating with hot water or steam, the water is heated in the heating apparatus, conveyed to the rooms, and there used to heat the iron of the radiators, which in turn heats the air. The difference between the two systems is, therefore, practically that in the hot air system, the air is heated by one central plant, while with hot water and steam, the air is heated by a separate plant or substation in each room, which substation is heated from a central station.

It is not my purpose to disparage the system of heating the air by individual heating plants, but to show some of the possibilities in heating the air by a central plant, a system which in my judgment, has been largely left to incompetent men, and has not received the attention and scientific study which it deserves. That this system has been in a large proportion of cases unsatisfactory, I freely admit, but believe that the failures have been due to errors in construction or operation and not to any inherent defect in the principle.

Heating the air by a central plant involves less expense in the installation, and this is a matter which demands the consideration of the practical engineer. Economy in first cost is not everything, but it is something, and with probably ninety-nine out of one hundred people who have homes to heat, a very vital something. While a really first-class hot air plant cannot be installed at the prices commonly charged for inferior and inefficient ones, yet even such a plant costs less than a hot water or steam system. Economy of first cost is, therefore, a possibility in heating with hot air.

But economy of operation is no less important. The plant is paid for once, the fuel bill is a continuing expense and frequently amounts to more in a few years than the first cost of the plant. No system is economical which involves a continuous useless expense.

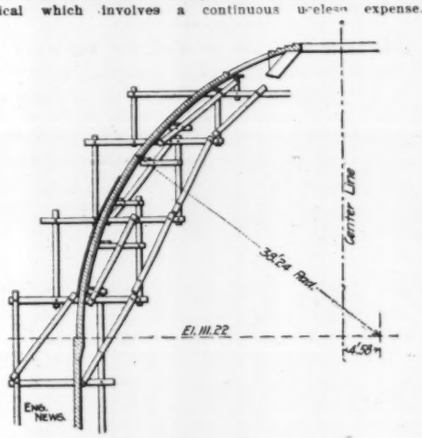


Fig. 12. Details of Falsework and Mold for Outer Dome Shell.

What are the specific facts in regard to cost of operation in heating with hot air? A given amount of fuel will in perfect combustion set free a given amount of heat, no more and no less. The heat is in the fuel, not in furnace or boilers. No heating apparatus can add a single unit. The theoretically perfect plant would be one in which there was absolutely perfect combustion of the fuel and complete utilization of the heat released by this combustion, and on these two points depends the comparative economy of operation.

On the first point, completeness of combustion, while there is large difference in different apparatus, there is no essential difference between the two systems. The fuel can be burned as perfectly, and as large a proportion of the heat units contained in it be released, with one system as with the other. The issue is, therefore, narrowed to what becomes of the heat after it is released from the fuel.

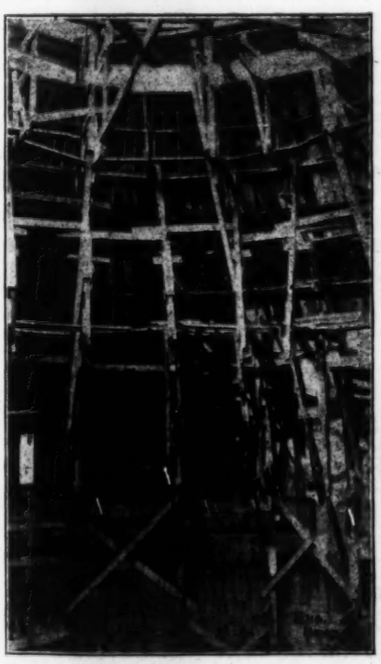


Fig. 13. View of Interior of Mold for Outer Dome Constructed as in Fig. 12.

Fig. 14. View in Space Between Outer Dome and Ceiling Dome, Showing Connecting Struts.

Heat cannot be destroyed. Once produced, it must either be transformed into some other form of energy or continue as heat. In house heating, it may be practically said that all the heat released by combustion either goes toward heating the house, that is, to replacing that which has been lost by radiation and leakage through walls and windows, or escapes up the chimney having performed no more useful function than the creation of a draft.

The extent to which the heat produced is utilized can, therefore, be practically determined by ascertaining the per cent. which escapes to the chimney. The lower the temperature at which the waste products of combustion escape to the chimney (velocity of current being the same) the larger will be the per cent. utilized for heating the house and consequently the greater the economy of operation. In other words, the extent to which the cooling of the products of combustion can be carried is the measure of the efficiency of any heating apparatus.

Let us see the theoretical limit to which the cooling can be carried, keeping in mind the fact that the theoretical limit can never be reached, much less passed, in practice.

The products of combustion are cooled by contact with metal which is cooled by contact with water or air. The theoretical limit of cooling is, therefore, the temperature of the air or water by which this cooling is accomplished. With live steam, the possible minimum is the temperature of water boiling under normal atmospheric pressure, or 212°. With hot water, the possible minimum is the temperature of the water as it returns to the boiler from the radiators, usually 140° to 170°. With hot air, the possible minimum is the temperature of the cold air entering the furnace, anywhere from below zero to 70°.

The theoretical limit of cooling and consequent theoretical economy in operation is, therefore, lower with hot water than with steam, and lower with hot air than with either hot air or steam. It is, therefore, possible—theoretically—to heat with hot air more economically than with any other system. But the advocates of the other systems will contend that while this may be so in theory, yet that in practice, owing to the greater power of water to absorb heat, it is otherwise, and that actually the exhaustion of the heat contained in the products of combustion is carried much further in both steam and hot water heating than it is in hot air heating.

In many cases, I admit the contention, but in turn I contend that the reason is to be found in the construction of the apparatus and not in the principle, and that it is entirely possible to so construct hot air apparatus that the same difference in its favor, as compared with hot water and steam, will exist in practice as is shown in theory.

In heating with hot air, however, there is an expenditure of heat which may perhaps be called waste, namely, the heat contained in the air which is forced out of the building by the pressure of the warm air that is being poured in. But this loss of heat is due to the necessity for ventilation. A given amount of ventilation will involve the same loss of B. T. U. whatever the heating system may be. It is true, with hot water or steam heat, it is possible to reduce the ventilation below the proper ratio and thus save heat; but this is equally possible with hot air, if the plant is so constructed that the amount of ventilation can be controlled.

It is true, that with hot air heating, ventilation can be carried to a point which will involve large loss, as I shall show hereafter. The same is true with hot water and steam. You can open the windows and crowd the fire. But in either case, the loss is to be charged up to ventilation, or bad management, and not to the system of heating, and can be as well controlled under one system as another.

It is a possibility in heating with hot air to heat all the rooms in a house at the same time. I am compelled to admit that this is not always done in practice. I could not even dispute the statement that it is not often done, but I can demonstrate both theoretically and practically that it can be done, and that which can be done is a possibility.

If the amount of cold air that is supplied to the furnace is equal to the amount that can be forced through all the hot air pipes; if the construction of the furnace is such that this amount of air can pass through the casing and reach the hot air pipes, with velocity unreduced by friction; if the furnace has the necessary surface and the necessary arrangement of surface to heat all this air; if the size and form of the hot air pipes is such as will permit the passage of the required amount of air to each room; and if there is no serious "back pressure" in any room, the furnace will heat them all at the same time. For if enough air is being pressed through the furnace to supply all that can be carried by all the pipes, the pressure in the furnace will force this air through all these pipes, if the resistance due to friction and back pressure in the rooms is less than the pressure in the furnace. That is a simple matter of mathematical demonstration.

There are a great many "ifs" in that claim? Certainly. And it is the business of the heating engineer to look after those "ifs." If he can't do it, he has not yet mastered his profession. These "ifs" cannot be met either by guesswork or by a set of hard and fast rules. They require a thorough scientific knowledge of the principles involved, a considerable amount of practical experience, and a liberal use of horse sense.

*A paper presented at the Chicago meeting of the American Society of Heating and Ventilating Engineers.

Air is compressible and elastic. It is subject to friction, inertia, and momentum. The fact that two pipes have the same area is not proof that the same pressure will force the same amount of air through each. To get proportions correct, is not a simple or easy matter, but requires the exercises of brains and judgment. It is possible in heating with hot air, to heat those rooms which are most exposed to the wind, or the windward side of large rooms. The course of heated air is subject to definite laws, and by the use of these laws, it can be controlled. But the man who would control it, must make himself familiar with these laws and not content himself with a lot of empirical formulas.

The cause of trouble in heating rooms exposed to the wind is that the air pressure on the outside by leakage produces air pressure in the room, and if the pressure in the room is greater than the pressure in the pipe, the greater will overcome the less. If the pressure of air on the outside is so great that the pressure of air in the pipe cannot force air out through the crevices around windows, and there is no outlet for the air, it will be impossible to force air into the room and consequently impossible to heat that room. But the difficulty can be overcome by providing a proper outlet, of the proper size and in the proper location.

Nothing has done so much to injure heating with hot air, as the common idea that neither skill nor scientific knowledge is needed in connection with it. The system has been neglected by scientific men, and the work is frequently turned over to common mechanics. In many places, the carpenter is given the job of having the house piped, and he turns it over to whoever gets the contract for roofing and spouting. The average man who would not think of laying out a shoe closet in the house he is building without consulting an architect, will give all the directions for putting in a furnace, determine its size, its location, the pipes and the registers. Then he expects the "furnace man" to put in the furnace on plans of the builder's selection, and guarantee the working of the plant. And, strangest of all, there are plenty of "furnace men" who will do it. No wonder guarantees on the working of hot air furnaces are worth but little.

There is one point in connection with heating with hot air, to which I have already referred, in which there is a possibility of great waste of heat. This is over-ventilation. Take a house in which the loss by radiation from walls is 80,000 B. T. U. per hour, in zero weather. To maintain the temperature by replacing this loss, will require the use of 62,857 cu. ft. of air per hour at a temperature of 140°.

Supposing the family consists of six persons, the maximum requirement for ventilation would be 11,800 cu. ft. per hour. In this case, we are using 51,057 cu. ft. of air per hour in excess of the amount required for ventilation. If this air escapes at 70° and has been heated from zero, it represents a loss of 64,963 B. T. U., or about 8 lbs. of coal per hour. In my judgment, the remedy for this is to make provision for recirculating this excess of air.

AUTOMATIC SIGNALING ON ELECTRIC RAILWAYS.*

By L. H. Thullen.† Assoc. Am. Inst. E. E.

Since the adoption of electricity for motive power on railways great changes have been made in the art of railway signaling. On steam roads the track can be subdivided into sections equal to the length of a block, but on electric roads the rails must be continuous so as to provide for the return of the propulsion current. At first one rail was made continuous and the other subdivided into sections equal to the length of the block. A source of current was supplied to one end of the block, and a relay having a polarized armature was placed at the other end. This relay was operative only by the track current which was connected in opposition to the current traversing the subdivided rail. This system is shown diagrammatically in Fig. 1 and needs no further explanaton. It was installed on the Boston Elevated Railroad in 1901, and is still in use.

Another system of more recent date, installed on the North Shore Railroad in California, and in the New York subway consists of the application of an alternating current to the track, and the use of a relay that will be operative by alternating current only. This system is shown in Fig. 2. A-A are block sections. B-B are transformers which transform current from a high pressure 500 to 2,000 volts—to about 10 volts for the track circuit. C-C are resistances placed between the transformer and track, and relay and track; the former to limit the amount of alternating and direct current flowing through the transformer, the latter to limit the direct current traversing the apparatus at the relay end of he block. D is a relay made to operate on the Ferraris principle. This relay will operate by alternating current only. E is an impedance coil of low ohmic resistance, which offers a free path for the direct current, but is traversed by only a small part of the alternating current. The impedance coil is, therefore, a shunt to the alternating-current relay; one object of the shunt coil is to limit the direct current that traverses the relay, for the presence of direct current causes the relay to operate in a sluggish manner. As the resistance of the relay is quite high compared to that of the impedance coil, very little of the direct current will traverse the relay.

In the system just described only a small current traverses the sectional rail. Means more recently devised whereby both rails can be utilized to a greater extent for the return current, are shown in Fig. 3, in which A are block-sections, from 2,400 to 4,000 ft. in length, B are inductive rail-bonds of a few turns of copper conductor of about 1,000,000 circular mils cross-section, C are transformers supplying current to the track, and D are relays operated by alternating current only, controlling the signals through the local circuit E. The latter is similar to the relays D of Fig. 2.

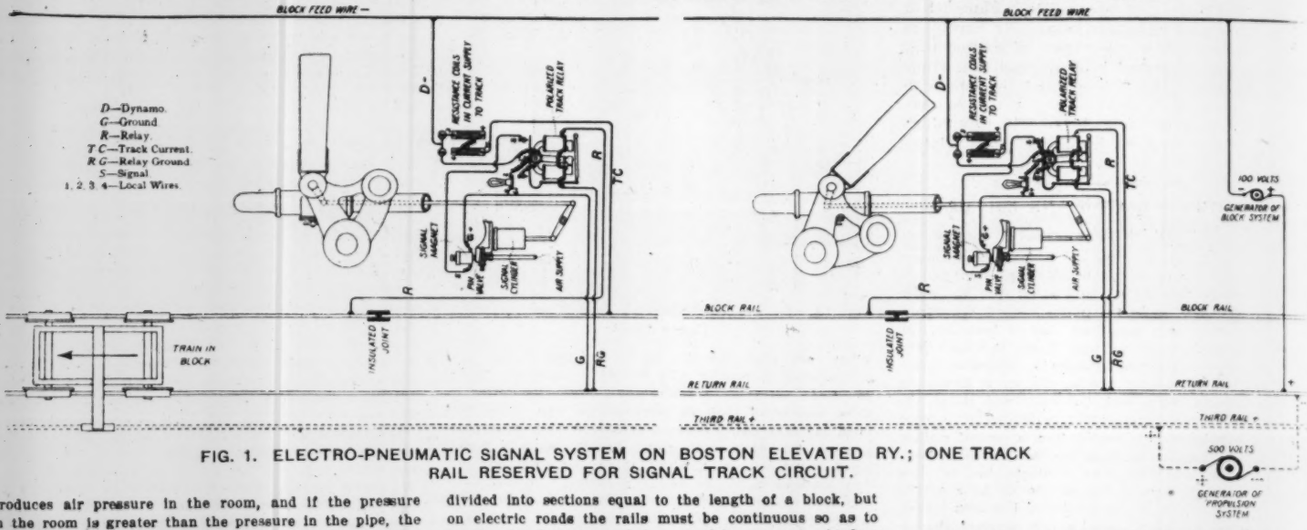


FIG. 1. ELECTRO-PNEUMATIC SIGNAL SYSTEM ON BOSTON ELEVATED RY.; ONE TRACK RAIL RESERVED FOR SIGNAL TRACK CIRCUIT.

The transformer is designed to have a large amount of magnetic leakage when the secondary is short circuited by a train in the block, thereby reducing the electromotive force of the secondary and the energy absorbed at that time.

The inductive rail-bond is shown in detail in Fig. 4. The bond is composed of a few turns of bar copper, and adds but small resistance to the track-section; in fact, the actual increase of resistance in a track-section 3,000 ft. long, due to the addition of these bonds, is only one-half of one per cent.; or, in other words, the efficiency of the track return is 99.5%.

As shown in Fig. 3, the propulsion current traversing each rail divides and traverses the bond in opposite directions, thereby neutralizing the magnetic action of the direct current; while the alternating current traverses the bond in only one direction, making the bond inductive to the track current. The question naturally arises: will the resistance of both rails be equal? It is not assumed that they will be, and this is taken care of by making the iron core of the inductive rail-bonds (Fig. 4) with an open magnetic circuit, the opening being made so large that no excessive unbalancing of the current between the rails will change the inductive effect of the bond.

The effect of direct current on impedance coils, with and without an air-gap, is shown by curves in Figs. 5 and 6. Fig. 5 shows the same winding and iron as used in the test shown by Fig. 6, except that in Fig. 6 the iron core has an air-gap of 0.125 inch. In Fig. 5 the least amount of direct current will make a great increase in the alternating current traversing the coil, while in Fig. 6 the direct current is increased to 600 amperes without any material increase in the alternating current. From 600 amperes to 1,200 amperes, the curvature is gradual; beyond 1,200 amperes the curves are quite flat. The air-gap may be made sufficiently long to take care of any reasonable amount of direct current.

The electromotive force at the relay is a little more than one volt. In blocks 3,000 ft. long there is a pressure of

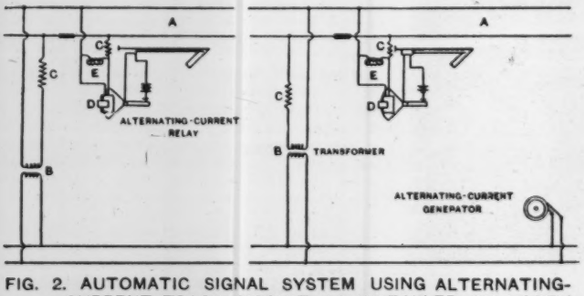


FIG. 2. AUTOMATIC SIGNAL SYSTEM USING ALTERNATING-CURRENT TRACK CIRCUIT, AS INSTALLED ON NORTH SHORE R. R. AND NEW YORK SUBWAY.

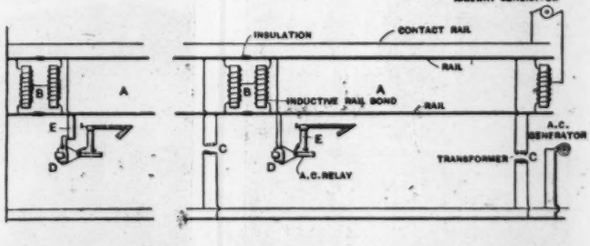


FIG. 3. IMPROVED ALTERNATING-CURRENT SIGNAL SYSTEM.

*From a paper, entitled "Electrical Features of Block Signaling," read before the American Institute of Electrical Engineers at Asheville, N. C., June, 1905.

†Electrical Engineer, Union Switch & Signal Co., Pittsburg, Pa.

about six volts at the transformer, the difference being due to the high impedance of the rail with the alternating current. The relay is placed at the entrance end of a block and the transformer at the exit end. With no train in the block, the energy absorbed by each block is approximately 50 watts. When a train enters the block at the relay end, the energy is seldom more than 75 watts, and about 300 watts when the train is exactly opposite the transformer. As the train is exactly opposite the transformer but a few seconds at a time, the average actual energy consumed is quite small.

LIGHT SIGNALS.

In the East Boston tunnel light signals only are used, as shown in Fig. 7. The signals have two colored lenses:

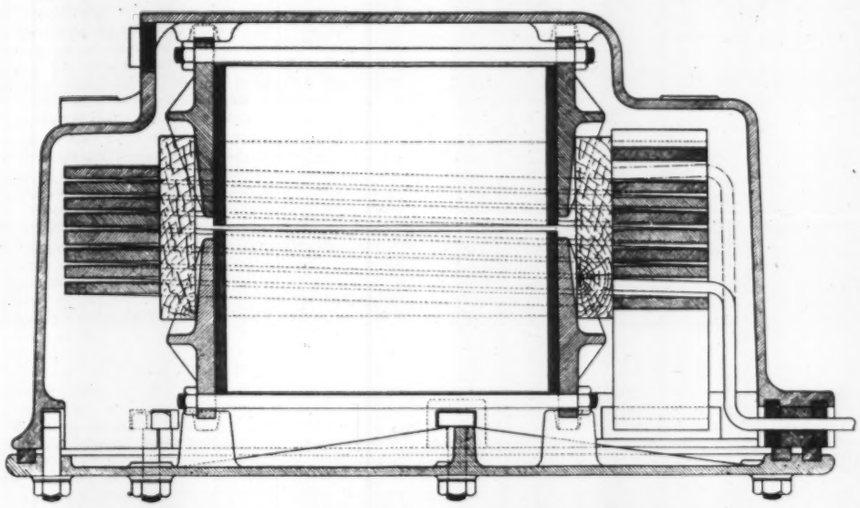


FIG. 4. INDUCTIVE RAIL-BOND FOR TRACK RAILS ON ALTERNATING-CURRENT SIGNAL SYSTEM.

red for danger, and green for safety. The signals are lighted by two 4-c. p., 50-volt lamps connected in multiple. The lamps are placed close together, and in line with the lens, the focus of the lens being midway between the two lamps. Very little difference in the action of the lenses is noticed by this arrangement. Low-efficiency lamps with a coiled filament are used; on account of their low pressure and low efficiency these lamps have long life. Being connected in multiple, both would have to be out at once before the signal would be out of commission; even then there would be no danger, as no light in a signal is considered a danger signal. The current for the lights is furnished from a separate winding on the transformer. The lamps are lighted and extinguished back of the different lenses by means of front and back contacts on the track-relays, the contacts being made between platinum and carbon, as no two metals could be used on account of the liability of fusing by arcing and lightning.

At this point it may be said that the layman usually believes that the rails of a track are less likely than any other part of the signal system to be struck by lightning, or to carry currents induced by lightning. Yet this is one point signal men have to contend against. The inductive discharge between rails is considerable, and numerous relays have been burned out or injured by lightning, notwithstanding they were built in the best possible manner and all parts tested by an alternating current of 5,000 volts as an insulation breakdown test.

Electrically-lighted signals are fast displacing the oil-lighted ones. They were adopted on the New York subway after very careful consideration, and their continued satisfactory working has more than justified their adoption. In an installation of this kind men are not required to fill and clean lamps. This means great saving in the cost of labor, and perhaps of life; for in a place like a subway, where space is limited and the trains are constantly running, it is of very great importance that the maintenance crew be kept as small as possible.

In the electrified subway portion of the Long Island Railroad electrically-lighted signals only are to be used. The signals are shown in Fig. 8. Four lights will be used: the two upper ones being the signals for the adjacent block, and the two lower ones for the second block in advance. The upper lens is red, danger; the one below, green, or safety; the upper one of the two lower lenses is yellow, or caution, and the lower one green, or safety.

On the elevated and surface portions of this road it is planned to use signals of the two-arm type operated by electric motors from storage batteries of six cells each, the batteries being charged by current taken from the third rail through a suitable resistance. About 250 of these signals are to be installed. Current at 2,000 volts and 25 cycles will be furnished the signaling system by mains extending the length of the track.

OPPORTUNITIES FOR ENGINEERING GRADUATES IN THE GOVERNMENT SERVICE.*

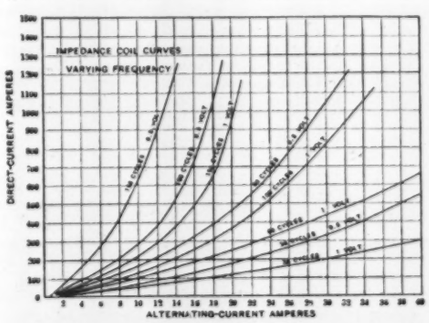
By John F. Hayford, Assoc. M. Am. Soc. C. E.†

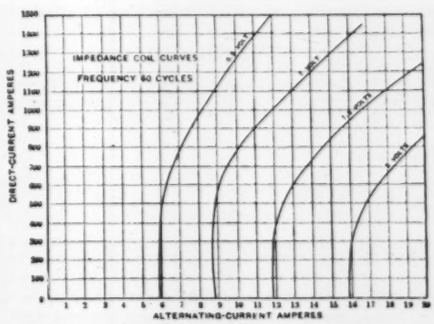
The civil service of the government is a vast organization, including more than a quarter of a million people. It is an extremely complicated organization, partly on account of the great variety of the work done by it, partly because it is a century's growth, not a creation.

I shall deal only with the opportunities for graduates in civil, mechanical, electrical and mining engineering. The opportunities for engineers from West Point will be omitted. They are closed to others. The Isthmian canal work will not be included, as I did not succeed in becoming well posted in regard to it. The positions for which the pay is less than $700 per year are also excluded from the statistics to be given. There will be included all positions to which the engineering graduate may hope to rise by merit, not simply the entering positions.

The statistics given are believed to be sufficiently accurate for the purpose and are expressed in round numbers. In cases of disagreement between different authorities the figures which make the government service less attractive are used.

Within the limits stated there are 2,600 opportunities for engineering graduates in the government service. For 46% of these positions the pay is between $700 and $1,400 per year; for about 32%, from $1,500 to $1,900; for 18%, $2,000 to $2,900; for 3%, $3,000 to $3,900; and for nearly 1%, $4,000 or over. These figures are for salary only, they do not include allowances for expenses, subsistence and quarters furnished, etc., which are received by many.





FIGS. 5 AND 6. CURVES OF COMPARATIVE TESTS, SHOWING EFFECT OF AIR-GAP IN MAGNETIC CIRCUIT OF INDUCTIVE RAIL-BOND.

(The curves show the amount of alternating current, at constant voltage, for various direct currents.)

There are nearly 700 opportunities under the Chief of Engineers of the Army, for engineering graduates. This force includes 180 assistant engineers or superintendents, 150 junior engineers, and 70 draftsmen. The Lake Survey is a part of this group of 700.

There are more than 500 opportunities in connection with navy yards and naval stations. This includes 40 civil engineers and constructors, and nearly 400 draftsmen.

In the engineering force of the Reclamation Service, under the Geological Survey, there are 300 engineers. This service is growing very rapidly and will probably continue to do so for several years. Hence, it furnishes the best chance in the government service for the rapid advancement of unusually able men, with the possible exception of the Panama canal work.

Three hundred patent examiners are employed in the Patent Office.

In the Coast and Geodetic Survey there are 140 opportunities for engineering graduates; 90 in the field force, 20 as draftsmen and 20 as computers.

There are 130 opportunities under the General Land Office.

The remaining 500 opportunities are scattered through the service. The largest groups are in the Topographic Branch of the Geological Survey, in the Revenue Cutter Service in charge of marine engines, under the supervising architect as superintendents, and in the Engineer Department of the District of Columbia.

New appointments are being made at the rate of about 200 per year to repair the waste in the force of 2,600 and to produce the steady expansion which is normally in progress.

Nearly all of the 2,600 positions are in the classified service, to which entrance is guarded by the civil service commission. How can a professor of engineering secure information in regard to these examinations, and in regard to positions in the government service to which his students may aspire?

By writing to the civil service commission in his official capacity, he may have the manual of examinations sent to him regularly twice a year. This contains, for all regular examinations, the announcement of the dates and places of examinations, and of the scope of each separate examination. It also contains information as to applications for examination, methods of appointment and conditions of first employment.

In the same manner, he may secure the annual report of the civil service commission containing information in regard to the manner in which the civil service act has been enforced and the civil service rules applied, and in regard to the general condition of the service. Incidentally, the report indicates the relative prospects of appointment in various lines. The official register of the United States contains a full list of the employees of the United States. Unfortunately, it may not be accessible to all of you.

For many examinations, especially examinations requiring technical qualifications, the civil service commission distributes special printed announcements about one month in advance of the examination. Any professor of engineering may have all such announcements, covering specified lines, sent to him regularly merely by making a request in writing to that effect. The student, or graduate may also, as an individual, apply for these announcements and receive them as they appear. Do not however, write for an application blank for an examination which has not yet been officially announced.

By using the manual and annual report and the special announcements of examinations, the professor of engineering may keep in close touch with nearly all the opportunities for appointment of his graduates to the classified civil service, except the following two large classes:

First, the 500 positions which have been referred to in connection with the navy yards and naval stations are filled by examinations held under the direction of the Navy Department, not the civil service commission. Many of these examinations are advertised and held only in the locality in which the appointment is to be made. Information in regard to these examinations must be obtained at the Navy Department at Washington, or from the officers having local charge of the work.

Second, there are two methods of entrance to the posi-

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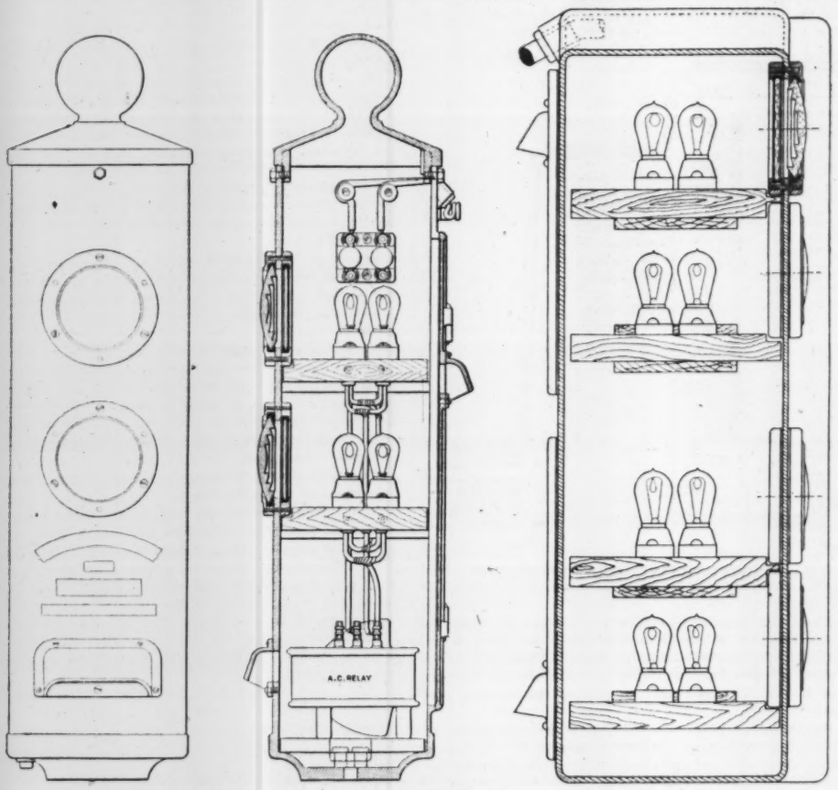
tion of junior engineer under the chief of engineers; namely, by a civil service examination, known as the "Civil Engineer, Departmental Service" examination, and by promotion from lower grades in the service, under the chief of engineers, such, for example, as inspectors, recorder, transitman, levelman, rodman or chainman. Appointments are made to these lower grades from registers of eligibles established at various points by local boards of civil service examiners, without examination. Any employee may be promoted from one of these lower grades to the grade of junior engineer on the recommendation of his employing officer, provided he passes



FIGS. 7 AND 8. TWO TYPES OF INCANDESCENT LAMP LIGHT-SIGNAL.

the appropriate examination held under the direction of the civil service commission. If he holds a diploma of graduation in an engineering course from an approved technical school he may, after one year's service, be so promoted without examination. This is the class to which your attention is especially called. For more complete data apply to the chief of engineers for the circular known as "Information concerning positions under the Engineer Department at large."

Information in regard to rates of promotion, prospects of promotion, character of service required, and the conditions of service, must, in general, be obtained from the different bureaus or departments concerned in much the same way that it is obtained in regard to positions outside the government service; that is, by correspondence or personal acquaintance with those in charge or with the employees. Such information cannot, except to a limited extent, be obtained from the civil service commission.

Promotions in the government service are made on merit. Merit is, as a rule, ascertained in much the same manner as in any large organization, by observation of the employee's work by his official superiors. It is placed on record by the recommendations of those superiors.

In the Reclamation Service, such recommendations are all placed twice a year in the hands of a committee of three men of high rank in the service who have a wide acquaintance with the personnel. This committee virtually decides what promotions shall be made, subject, of course, to approval. A similar system is in force in the Geological Survey as a whole.

Under the chief of engineers promotions from junior engineer to assistant engineer depend upon recommendations by the official superiors but are also subject to two conditions. The candidate must, at some time, have passed the civil engineer examination before the civil service commission, and he must possess the professional qualifications that are required for full membership in the American Society of Civil Engineers. In general, an assistant engineer is selected from among the junior engineers in the district in which he is to serve. That is, the civilian employees in general stay in a given district on the work with which they are familiar, though the officers of the corps of engineers, under whom they serve, are periodically transferred from station to station.

As a rule, any attempt on the part of a government employee to bring political influence to bear to secure a promotion is interpreted as a confession on his part that he does not feel that he has sufficient merit to warrant promotion. The confession is apt to be taken at face value. Such confessions are rare.

The theory of the system of promotion is that since the reputation of the executive officer depends directly and intimately upon the efficiency of the force under him, he can be depended upon for selfish, as well as unselfish, reasons to promote the best men.

There is a saying that in the government service few die and none resign. How much truth is there in it? About as much as there is in the mother-in-law joke. In the portion of the service in which the tendency to remain for life is apparently greatest, namely in the classified service in Washington, there are about five times as many resignations as deaths each year. In the civil service as a whole, there are about ten times as many resignations as deaths.

Closely associated with the idea that few die and none resign is the idea that all work under fixed salary lists, that no promotions can be made except to fill vacancies caused by death or resignations, and that such promotions are based almost entirely on seniority. Only about one-half of the 2,000 engineers are paid from a fixed salary list. The remainder are paid from lump sum appropriations. Where the fixed salary list exists, seniority is considered, and properly so, in making promotions, but it does not control when there is a well worked difference of merit in favor of the junior.

An unsuccessful attempt was made to secure statistics as to the rates of pay of engineers outside the government service for comparison with those given in the first part of this paper. I shall be much indebted to any one who can put me in the way of obtaining such statistics.

In comparing the rates of pay stated in this paper with similar rates outside the government, four advantages of the government service should be kept in mind. First, the government is liberal in paying traveling expenses and subsistence, and in some cases, in furnishing quarters. Second, the hours of service required by the government in office positions are short. Third, the government employee is liberally treated in regard to leave with pay. Fourth, the engineer under the government has more continuous service, as a rule, than an engineer outside. Even under the great corporations, such as the largest of the railroad systems, the service is much less continuous than under the government. A change among the higher officials railway service frequently leads to many chang subordinate positions on account of favoritism. new official brings with him the subordinates with he is acquainted and makes removals to provide for them. On account of restrictions by the civil se act and rules, and for other reasons, these whol removals do not occur in the government service.

There is a prejudice against the government se on the ground that young men do not get a chan develop, that they are kept in minor positions with responsibility, that they lose energy, that their po of initiative remain undeveloped. In so far as engi in government work are concerned, this prejudice b little relation to the facts. As a rule, the young e neer is worked hard, and is given all the responsib he is competent to carry. The officials in control constantly hunting among their subordinates for men will stand responsibility. In the Coast and Geod Survey the captain of one of the steamers engaged Philippine surveys has been out of college but years, and the commander of the finest survey steamer the Atlantic has had but 12 years' experience in the s vey, and has already been in command 3½ years.

The government service has disadvantages. They the disadvantages which are inherent in services with large organization. The opinion of the average man in regard to the government service is based on the tr ditions and prejudices of a generation ago, not on pr ent facts. The merit system began to go into effect b little more than 20 years ago. You are asked to jud the service by the present facts. The speaker is confi dent that if you examine the facts thoroughly you w find that he has not overstated the case in favor o Uncle Sam.

The engineering work of the government is done in an energetic, efficient manner. If you send your be graduates to it, you will find, either that they stay with it because they like it, or that they will go out into othe work and will find that their experience in the govern ment service has been a valuable training to them. If you send your poorest men to us you will find them, in time, squeezed out by better men.

THE RELATION OF VARIABLE LOAD TO COST OF TRANSMISSION IN ELECTRIC RAILWAY PROBLEMS.

By Sydney W. Ashe.*

The cost of transmitting electrical energy is an important consideration in nearly all electrical problems. On a given circuit the power lost in transmitting a given current is equal in watts to the line resistance in ohms multiplied by the square of the current in amperes. In the case of circuits carrying variable load, the line loss also varies. The following shows how it may be found from the load diagram.

The relation of actual line loss to ideal line loss may be called "cost factor." Ideal line loss is here taken to be the line loss which would occur with steady load in place of the variable load. Since for a given daily load the ideal line loss is easily computed, it is necessary only to determine the cost factor under given conditions of varying load. The cost factor is obviously greater than unity.

The line current is represented graphically in a station load diagram, Fig. 1. The heating effect

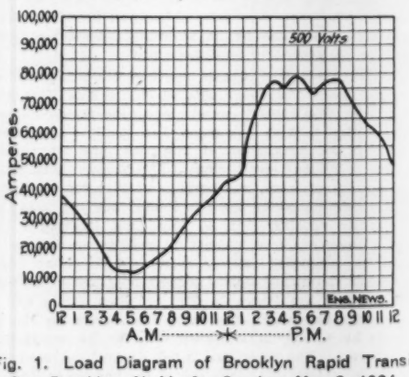


Fig. 1. Load Diagram of Brooklyn Rapid Transit Co., Brooklyn, N. Y., for Sunday, May 8, 1904.

or line loss at any moment will be proportionate to the square of the current, and the total heating effect throughout the diagram is therefore proportionate to the mean square current value. The latter may be obtained from the diagram by

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either of two methods: (1) Squaring the successive current values, at short time intervals, and plotting the resulting values on the same abscissas as the load diagram; the area of the curve can be found with a planimeter; dividing this area by the length of diagram gives the mean square ordinate, and multiplying the latter by line resistance gives the average line loss in watts. (2) By means of an instrument called the integraph the area of the current-squared curve may be found directly, and the line loss then computed as before.

The ideal line loss is easily found by averaging the original ampere or load diagram (either by planimeter or by arithmetical averaging), squaring the average current and multiplying by the line resistance.

Letting

I_1 = average current,

I = square root of mean square current,

r = line resistance;

then,

$$\text{Cost Factor} = \frac{\text{Actual Line Loss}}{\text{Ideal Line Loss}} = \frac{I^2 r}{I_1^2 r} = \frac{I^2}{I_1^2}.$$

EXAMPLE 1.—The curve in Fig. 1 is the load diagram for the Brooklyn Rapid Transit System for Sunday, May 8, 1904 (extracted from the Transactions of the Brooklyn Engineers' Club). To find the cost factor for the line loss, by averaging the hourly ordinates the average current is found to be 47,000 amperes. By squaring the hourly ordinates and averaging, the mean square current is found to be 2,850,000,000 amp.^{2} For work with the planimeter, the values of current squared would be plotted on the diagram to an arbitrary scale as shown in Fig. 2. Then two operations with the planimeter give the areas of the ampere curve and the amperes-squared curve, which divided by the length of the diagram give the same values as found arithmetically.

$I_1 = 47{,}000,$

$I^2 = 2{,}850{,}000{,}000.$

The cost factor for this case is, then,

$$\frac{I^2}{I_1^2} = \frac{2{,}850{,}000{,}000}{47{,}000 \times 47{,}000} = 1.29$$

Thus the line loss on the system on May 8, 1904, was 29% greater than if the load had been constant.

The installed capacity of this system is 50,000 KW. The average load during the day mentioned, the pressure being 500 volts, was $47{,}000 \times 0.500 = 23{,}500$ KW. The line loss of the system is stated to be about 15%, or on this day $23{,}500 \times 0.15 = 3{,}525$ KW. Since the line loss on varying load $= I^2 r$, and the value I^2 has already been found, we can find the line resistance, thus,

$$r = \frac{3{,}525{,}000 \text{ watts}}{2{,}850{,}000{,}000} = 0.00122 \text{ ohms.}$$

EXAMPLE 2.—What was the line-loss cost factor of the same system on Friday, May 6, 1904, the load diagram being given in Fig. 3? It will be observed that this curve is for a week-day and differs materially from that of Fig. 1, having two peaks instead of one. The average current here is 36,000 amperes, the mean square current is 1,580,000,000 and the cost factor is

$$\frac{1{,}580{,}000{,}000}{36{,}000 \times 36{,}000} = 1.22.$$

The "effective" current $= \sqrt{1{,}580{,}000{,}000} = 39{,}700$ amperes; this current would produce the same line loss as the actual load diagram of Fig. 3. In Fig. 3 is also drawn the curve of current-squared.

INVESTIGATION OF THE EFFECT OF HEAT UPON THE CRUSHING STRENGTH AND ELASTIC PROPERTIES OF CONCRETE.*

By Ira H. Woolson,† M. Am. Soc. M. E.

It is well known that concrete in a building construction will withstand the attack of a fierce conflagration for some hours and retain its stability of form and strength. This has been proven by actual fires in buildings, and repeated severe fire tests upon full-sized floor unites and partitions. It is also well known that concrete constructions have occasionally failed during conflagration and during official fire tests being made to determine the efficiency of some particular method of reinforcement. The causes of these failures were not always well defined. Usually they have been directly traceable to defective metal protection, unwise design of structural parts, or to the fact that the concrete was too green when subjected to the test. In some cases, however, the cause of failure was not entirely clear and much speculation has been rife as to just what degree of heat a concrete would stand before its strength and elasticity would be affected. This study was undertaken as an effort to throw some light upon this interesting subject.

The first step was to ascertain what previous work had already been done along the same line and the results obtained. A careful examination of the transactions of the engineering and scientific societies and the leading American technical journals for several years back furnishes very meager information.

The fire tests of reinforced concrete, such as have been conducted by the British Fire Prevention Association in London, and by the writer in co-operation with the Bureau of Buildings in New York City and elsewhere, have for their purpose the determination of three properties: 1st, effect of a continuous fire at 1,700° or 2,000° F., for three or four hours; 2d, effect of the application of a strong stream of water at short range while the material is still at a high temperature; 3d, amount of deflection due to a load during the fire, and subsequent increased loading to 600 lbs. per sq. ft. after the structure has cooled. The methods of construction and character of test are regulated by municipal specifications in this country, and by rules of the British Fire Prevention Committee in England.

The concretes used have included trap, limestone and cinder, and were usually 1-2-4 or 1-2-5 mixtures. The reports of numerous tests of this character were examined and in most instances the concrete stood the heat and subsequent loading well, but the results were general and referred to the quality or resistance of a particular construction rather than to specific data regarding the concrete itself. Large numbers of tests of compressive strength and elastic properties have been made upon concretes of various composition and after different preliminary treatments, but no records were found in which the concrete was heated prior to testing.

The report of the U. S. Arsenal at Watertown, Mass., for 1902, contains data of tests of neat cement cubes of several brands, which were heated before crushing. A synopsis and discussion of these is given by James E. Howard in the May, 1905, issue of "Cement," and some of his conclusions are given, since it is fair to assume that the action of neat cement under heat should be at least a slight criterion of that of concrete. The following is a summary of the results reported by Mr. Howard.

It was desired to ascertain the effect of elevation of temperature alone without introducing internal strains incident to a state of unequal temperatures in different parts of the specimen. The test pieces were 4-in. cubes cast slightly more than a year previous. Tests were at intervals of from 4 days to 4 months after heating. The cubes were gradually raised to the recorded temperatures. The heating took one hour, the maximum temperature was held one hour, and the specimens were then allowed to cool slowly in dry sawdust or powdered asbestos. During the heating the specimens developed fine cracks; these were hardly visible immediately after cooling nor were they one day later. Four days after heating they were generally developed and at eleven days they were nearly at a maximum. The effect upon the crushing strength was not serious when the cracks were fine, as the parts fitted together under pressure.

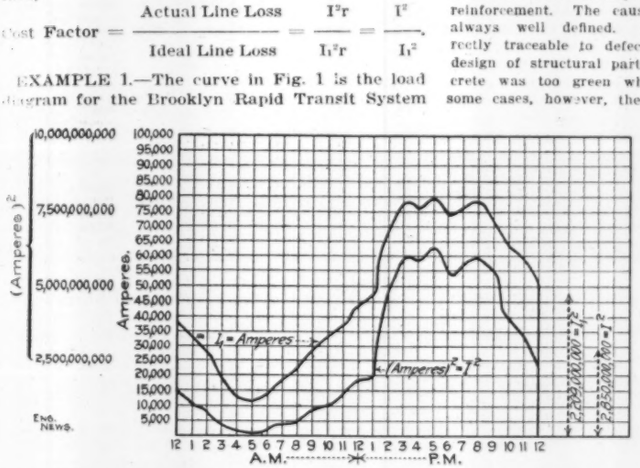

FIG. 2. LOAD DIAGRAM AND CURVE OF CURRENT-SQUARED. BROOKLYN RAPID TRANSIT CO., SUNDAY, MAY 8, 1904.

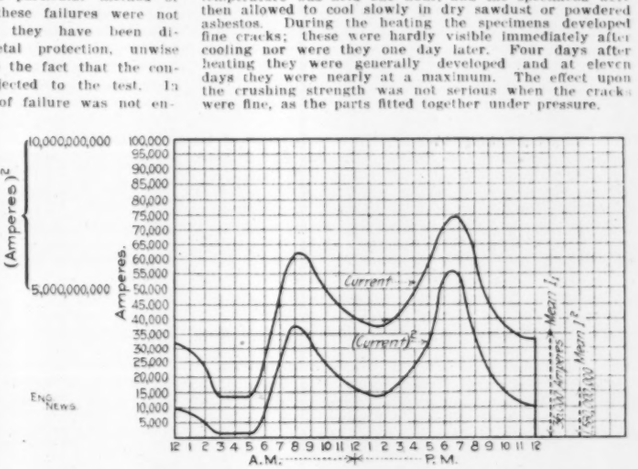

FIG. 3. LOAD DIAGRAM AND CURVE OF CURRENT-SQUARED. BROOKLYN RAPID TRANSIT CO., FRIDAY, MAY 6, 1904.

Table I shows the variation in ultimate crushing strength of the cubes. Each result is an average of three tests. This indicates that there is no decrease in strength up to a temperature of 600° Fahrenheit, but for higher temperatures the strength diminishes quite rapidly.

A search for previous similar investigations was so fruitless, it was evident that our explorations were to be conducted in practically an untrodden field, so the method of procedure was the next consideration, the desire being to make the conditions conform as nearly as possible to practice.

Since all the factors which enter the concrete problem are variables, it is extremely difficult to arrive at even a partial solution under any one set of conditions. There is, first, variation in the quality of the cement; second, difference in size, sharpness and cleanness of the sand; third, size and quality of the stone, gravel, slag or cinders used; fourth, variations in the proportions of the three solid ingredients and the amount of water used, and, fifth, method of mixing and treatment after casting, including age before testing. This latter is quite important, for it is well known that the strength of concrete increases rapidly for a period of six to twelve months after casting and continues to increase slightly up to two or more years.

It was decided to make the concrete a 1-2-4 mixture of cement, sand and ¾-in. broken stone, this being a common mixture used in constructing reinforced concrete floors. The cement was supplied by your Committee on Concrete and consisted of a mixture of different brands of the best grades of Portland. The sand was taken from a quantity being used in the erection of a new building on the University grounds. It was of medium size (90% passing a 12 mesh sieve), fair quality, and not especially clean. Two varieties of stone were employed, Hudson

*A paper read before the American Society for Testing Materials at Atlantic City, N. J., June, 1905.

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TABLE I.—Effect of Previous Heating on Crushing Strength of Neat Cement and 1:1 Sand Mortar. (Watertown Arsenal, 1902. J. E. Howard.)

Composition. Cement.	Sand.	Not Heated.	Ultimate Crushing Strength in lbs. per sq. in. After Heating. 200°	300°	400°	500°	600°	700°	800°	900°
Temperatures, Deg. F....										
1 Alpha*	..	9167	8830	7920	9190	9400	9333	8217	8060	6060
1 Alpha†	..	12480	14447	13767	13910	12787	12130	12130	9985	....
1 Dyckerhoff*	..	5017	....	....	....	....	4313	3483	4280	....
1 Mankato*	..	1867	1657	1876	1906	1903	1453	1496	1400	1185
1 Mankato†	..	3873	4043	3523	3810	4133	4133	3957	3900	2990
1 Mankato*	1	538	491	432	....	471	....	381	....	317
1 Mankato†	1	2170	2097	1953	....	2063	....	2240	....	1767

* Cubes set in air. † Cubes set in water.

FIG. 1. APPEARANCE OF 4-IN. CUBES OF LIMESTONE CONCRETE THREE DAYS AFTER HEATING TO TEMPERATURE OF 2,000-2,250° F.

River blue limestone and Hudson River trap-rock. Two sets of specimens were prepared which were duplicates in every respect, except that one contained limestone and the other trap-rock.

The mixing and casting were done by a laborer familiar with concrete work. A moderately wet mixture was used, tamping in the molds being continued until the surface of the concrete became flushed with water.

The investigation had three primary objects. First, to ascertain at what temperature the concrete began to lose crushing strength due to heat treatment; second, the rate at which strength decreased as a result of increase of heat, and last, but not least, the effect of varying temperatures upon the elastic properties of the concrete; the purpose being to determine if the elasticity began to diminish prior to the strength or concurrently with it. It was decided to make 500° F. the initial heat, and then to increase the temperature by intervals of 250° F. to 2,250° F., testing specimens at each temperature. The upper temperature limit was well above the average of a burning building, which is conservatively estimated by most experts as ranging from 1,500° to 2,000° F.

The determinations of crushing strengths were made upon 4-in. cubes; for the elastic properties, prisms 6 × 6 × 14 ins. were used, the height being sufficient to allow the measuring of compression on a length of 12 ins., and the cross-section being large enough to avoid the necessity of considering the specimen as a column.

To establish the quality of the concrete, three cubes and three prisms of each composition were first tested without being heated; then three cubes and two prisms of each composition were tested at each temperature.

METHOD OF HEATING.—The heating to 1,750° F. was done in an oven type of gas furnace. The furnace had a capacity of twelve cubes or two prisms and also allowed room for protecting them from the flames with fire bricks placed around the sides and top. The specimens were kept from contact with the floor by being supported on iron rods. Above 1,750° F. the heating was done in a large gas crucible furnace.

TABLE II.—Compressive Strength of 4-in. Trap-rock Concrete Cubes.

Specimen No.	Age in Days. Before Heating.	Between Heating and Testing.	Heated to Degrees F.	Ultimate Strength lbs. per sq. in.	Condition After Heating.
1....	32	....	Unheated	1905	
2....	32	....	"	1913	
3....	32	....	"	1892	
4....	36	2	500	1808	
5....	36	2	500	2100	
6....	36	2	500	1853	
7....	36	2	750	1880	
8....	36	2	750	1690	Slight cracks.
9....	36	2	750	1950	
10....	36	2	1000	1547	Brittle and full of minute cracks.
11....	36	2	1000	1273	Same.
12....	36	2	1000	1418	Same.
13....	36	2	1250	1110	Brittle and had several small cracks.
14....	36	2	1250	1163	Same.
15....	36	2	1250	1459	Same.
16....	50	10	1500	1265	Few cracks; appears sound.
17....	50	10	1500	1802	Sound; no cracks.
18....	50	10	1500	1602	Same.
19....	50	10	1750	644	Full of cracks.
20....	50	10	1750	1220	Same; one crack extending entirely around.
21....	50	10	1750	904	Full of cracks.
22....	44	9	2000	680	Full of cracks; one extending around 3 sides.
23....	44	9	2000	1072	Few cracks: surface was pitted.
24....	44	9	2000	790	Same.
25....	44	9	2250	458	Slightly fused on one edge; few cracks.
26....	44	9	2250	626	Very much fused on bottom.
27....	44	9	2250	420	Full of cracks; slightly fused on one edge.

To insure equal heating throughout the specimen, the rate of heating was arbitrarily fixed at 45 minutes to reach the first 500°, and 30 minutes for each successive 250°, the maximum heat being held 10 minutes before removing the specimen. This method subjected the prisms to a shorter period of heating than the cubes for every temperature except 500°, because the former was brought to the required temperature, held there, and then removed. The latter were charged into the furnace 12 at a time, brought to the proper heat, held there 10 minutes, and three cubes removed; then the temperature was raised 250°, and held again. This being continued until the last cubes were removed. Good results were obtained for the cubes for all temperatures, but it is doubtful if the prisms were uniformly heated at temperatures under 1,250°, as will be explained later.

Temperatures were measured continuously by a Le Chatelier pyrometer. The thermo-couple was located about 4 inches above the floor of the furnace and closely surrounded by the specimens.

After heating, the specimens were immediately removed from the furnace asd allowed to cool in the air. The testing was done at intervals up to three weeks subsequent to the heating.

METHOD OF TESTING.—The tests were made upon a Riehle testing machine of 100,000 lbs. capacity. The cubes were faced on the upper surface with plaster of paris, the lower face being in all cases smooth enough to require only a few sheets of blotting paper to insure a firm bearing. The pressure was applied to the top and bottom faces as determined by their position in the mold. The pressure was applied very slowly and steadily until the specimen failed.

The prisms were faced on both ends with plaster and compressions measured on a gaged length of 12 ins. by an electric contact extensometer adjusted to the specimen.

TABLE III.—Compressive Strength of 4-in. Limestone Concrete Cubes.

Specimen No.	Age in Days. Before Heating.	Between Heating and Testing.	Heated to Degrees F.	Ultimate Strength lbs. per sq. in.	Condition After Heating.
1....	34	....	Unheated	1968	
2....	34	....	"	1843	
3....	34	....	"	1640	
4....	38	3	500	1227	Somewhat brittle.
5....	38	3	500	1290	Same.
6....	38	3	500	1184	Same.
7....	38	3	750	1122	Brittle, and metallic sound when struck.
8....	38	3	750	1440	Same.
9....	38	3	750	1170	Same.
10....	38	3	1000	923	Stone slightly calcined.
11....	38	3	1000	991	Same.
12....	38	3	1000	1214	Same.
13....	38	3	1250	988	Calcination throughout.
14....	38	3	1250	1038	Same, but appeared sound.
15....	38	3	1250	903	Same, surface discolored.
16....	44	3	1500	680	Same, edges chipped.
17....	44	3	1500	778	Same, full of small cracks.
18....	44	3	1500	888	Same, crumbles easily.
19....	44	3	1750	832	Same, and discolored.
20....	44	3	1750	684	Very fragile.
21....	44	3	1750	922	
22....	44	3	2000	....	Crumbled on cooling.
23....	44	3	2000	....	Same.
24....	44	3	2000	....	Same.
25....	44	3	2250	....	Same.
26....	44	3	2250	....	Same.
27....	44	3	2250	....	Same.

The load was applied at the same rate as for the cubes. It is important that the load should not be applied faster than the concrete will adjust itself to the new stresses, or a fictitious strength will be recorded and instrument readings will alter until an equilibrium has been established. Compressions were measured at loads of 0, 25, 50 and 100 lbs. per sq. in., and then by increments of 200 lbs. per sq. in., until indications of failure forced the removal of the instrument. Sets were measured one minute after the removal of each load, this interval being found sufficient to allow the specimen to assume a stable condition.

It was originally intended to have the concrete at least sixty days old before testing, but owing to an unavoidable delay in securing part of the material it became necessary to test the specimens when a little over a month old. This was much to the disadvantage of the concrete

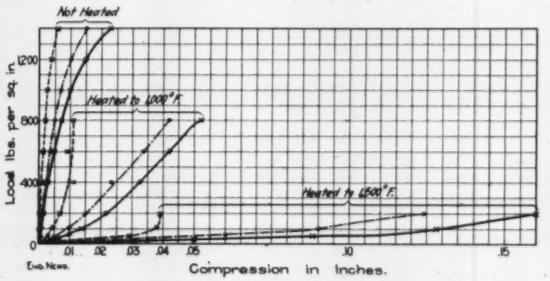


Fig. 2. Typical Curves of Trap Concrete.

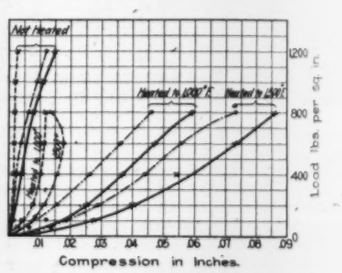


Fig. 3. Typical Curves of Limestone Concrete.

FIGS. 2 AND 3. TYPICAL STRESS-STRAIN CURVES OF NORMAL CONCRETE AND CONCRETE PREVIOUSLY EXPOSED TO TEMPERATURES OF 1,000 AND 1,500° F.

Test pieces 6 × 6 ins., 14 ins. high, of 1:2:4 concrete. Compressions measured on 12-in. length. Test pieces heated at ages of 33 to 57 days, then cooled slowly, and tested 3 to 19 days later.
Full lines give Total Deformation.
Dotted lines give Sets.
Dot-and-Dash lines give True Elastic Deformation = Total Deformation minus Set.

TABLE IV.—Compressive Strength and Modulus of Elasticity of Trap-rock Concrete Prisms.

Specimen No.	Age in Days. Before Heating.	Between Heating and Testing.	Heated to	Ultimate Strength in lbs. per sq. in.	E at 200 lbs. per sq. in.	E at 600 lbs. per sq. in.	E at 1,000 lbs. per sq. in.	Condition After Heating.	Specimen No.
2....	33	....	....	1,560	3,450,000	2,140,000	1,700,000	Specimen in good condition.....	2
3....	33	....	....	1,820	3,180,000	3,000,000	2,440,000	Same.....	3
4....	34	....	....	1,725	3,340,000	2,070,000	1,610,000	Same.....	4
10A..	48	6	500° F.	1,404	715,000	902,000	883,000	Same	10A
11A..	48	6	500°	1,970	834,000	950,000	1,040,000	Same	11A
12B..	49	3	750°	1,250	490,000	526,000	472,000	Very minute cracks apparent.....	12B
13B..	49	3	750°	835	400,000	461,000	.....	Appeared sound, but brittle.....	13B
16C..	50	5	1,000°	735	128,000	171,500	.....	Same, had a metallic ring when struck	16C
17C..	50	5	1,000°	1,100	160,000	212,000	.....	Same.....	17C
20D..	54	3	1,250°	910	89,000	122,000	.....	Surface covered with small cracks...	20D
21D..	54	3	1,250°	1,055	83,000	125,000	.....	Same.....	21D
24E..	56	9	1,500°	250	19,400	.....	.....	Very bad specimen, sides warped and shattered.....	24E
25E..	56	9	1,500°	....	.....	.....	.....	Worse than 24E.....	25E

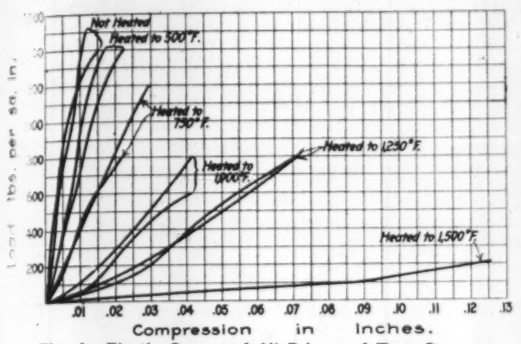


Fig. 4. Elastic Curves of All Prisms of Trap Concrete.

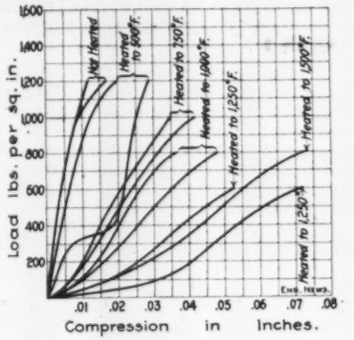


Fig. 5. Elastic Curves of All Prisms of Limestone Concrete.

FIGS. 4 AND 5. ELASTIC CURVES OF NORMAL CONCRETE AND CONCRETE PREVIOUSLY EXPOSED TO VARIOUS TEMPERATURES FROM 500° TO 1,500° F.

Test pieces 6 × 6 ins., 14 ins. high, of 1: 2: 4 concrete. Compressions measured on 12-in length. Test pieces heated at ages of 33 to 57 days, then cooled slowly, and tested 3 to 19 days later.
Two Specimens tested for each Temperature.
All Curves give True Elastic Deformation = Total Deformation minus Set.

in the fire tests, and it also accounts for the rather low values obtained in the tests of unheated specimens.

RESULTS.—Table II. gives the ultimate crushing strength of the 4 inch trap cubes which were heated to various temperatures and crushed after cooling. No appreciable effect upon the strength can be noted until a temperature of 750° is reached. This gave slightly lower average strengths. Beyond 750° the decrease was marked, though there were two or three exceptions to the rule notable at 1,500°, where two of the specimens gave remarkably high results. Why these cubes should have withstood the heat so much better than the others is not known. With the above exception, the surface of all specimens heated over 750° were covered with minute cracks. At 2,250° F. the cubes were slightly fused, due to the fact that fire brick protection was displaced in removing previous specimens, and the remainder were more or less exposed to direct contact with the flames.

Table III. gives similar data for the limestone cubes. The three unheated cubes show an average strength only slightly inferior to that of the trap mixture. Heating to 500°, however, gave a great loss in strength. There were no evidences in the appearance of the cubes indicating this deterioration. No further weakness resulted at a temperature of 750°, but beyond this the loss of strength continued. After heating to 2,000° and 2,250° the cubes appeared strong and in good condition while hot, but when cold they began to disintegrate, and at the end of three days their appearance was as shown in Fig. 1. No attempt was made to test these specimens.

Table IV. contains the results of the tests upon the elastic properties of trap-rock prisms. Three curves were also plotted for each specimen: 1, total deformation; 2, set; and 3, true elastic. The latter was obtained by Professor Bach's method, viz., by subtracting from each total deformation reading the corresponding set reading. Modulus of elasticity (E) was figured for three points of the true elastic curve.*

Taking the age into consideration the values for the unheated specimens compare favorably with the results of other investigators. As is usual, the value of E diminishes with increase of pressure. With the heated specimens this is not so marked, in fact, it is often the reverse, particularly with the intermediate loading. There is, however, a very marked decrease in the value of E due to the heating. This change becomes very apparent even with a temperature of 500° and the value gradually decreases with the increase of heat. There were some erratic results, but later investigation makes it quite certain they were due to imperfect heating.

After the elastic measurements on the prisms were completed the extensometer was removed and the specimen loaded to failure. The ultimate crushing strengths which were thus obtained are given.

Table V. gives the same data for limestone prisms. The moduli for the unheated specimens are about the same as those obtained by the writer on a series of similar tests recorded in Engineering News of June 1, 1905, the average value of E obtained there being approximately 3,600,000 for a sand-lime-stone concrete 55 to 58 days old, and the average here found being 3,300,000 for prisms 20 days younger of like composition.

The value of E falls rapidly with increase of heat applied, the same as for the trap-rock mixture.

The surfaces of the prisms of both mixtures were covered with minute cracks after being subjected to over 750° and then cooled. These cracks increased in number and size as the heat became higher, and at 1,500° the prisms began to warp and disintegrate on cooling. This deterioration increased with time, and at the end of nine days one prism of each mixture was so badly crumbled it was unfit for test. The others were very much weakened. This disintegrating effect is probably due to the swelling of the cement as a result of recalcination.

The curves of all the heated specimens show a large deformation in the early part of the test when the loads were comparatively light. This gradually lessens as the loads increase and the middle portion of each curve approaches a straight line and then falls off again when ultimate failure begins. The large deformation at first is doubtless due to the closing up of the numerous fire cracks previously mentioned.

A peculiar characteristic of many set curves for both mixtures is the tendency they have to reverse direction and go back towards the axis. A conspicuous example appears in Fig. 3. No satisfactory explanation for this behavior has been suggested.

It will be noted that the elasticity of the specimens decreased rapidly with the increase of heat. This is clearly shown in Figs. 2 and 3, where all three curves for each test of *three typical specimens* of each mixture are plotted to the same scale, showing the character of the total deformation, set and elastic curves without heating, and the corresponding curves for specimens which had been heated to 1,000° and 1,500° F. respectively.

The "true elastic" curves of *all* the prisms tested are grouped in Figs. 4 and 5, which indicate very plainly the gradual decrease of elasticity due to heating of the concrete.

The gradual decrease in strength of both cubes and prisms due to heat treatment is shown by the curves in Fig. 6. In general, the trap-rock mixtures were the stronger. There were some irregularities, which undoubtedly resulted from defective heating. Fig. 7 shows graphically the drop in the value of E for both mixtures due to heating.

As stated in the early part of this paper, the length of time a specimen should remain in the furnace to bring it to a certain heat was fixed beforehand, and with the 4 in. cubes the rate of heating employed appeared to give them uniform treatment throughout.

It was supposed the prisms would heat uniformly also in the time allowed, but subsequent results raised doubts regarding this. However, owing to the delays previously mentioned it was now too late in the season to duplicate the specimens and get them tested this spring, so the tests were completed and this report is rendered upon the data obtained.

Table VI. gives the actual times of heating for each class of specimen. It is known now that the time allowed for the prisms was not nearly sufficient to insure uniform temperature throughout. This is particularly true for the low temperatures. With the high temperatures the variation was probably not so great.

A test was recently made of the conductivity of the concrete in the prisms under the conditions of heating em-

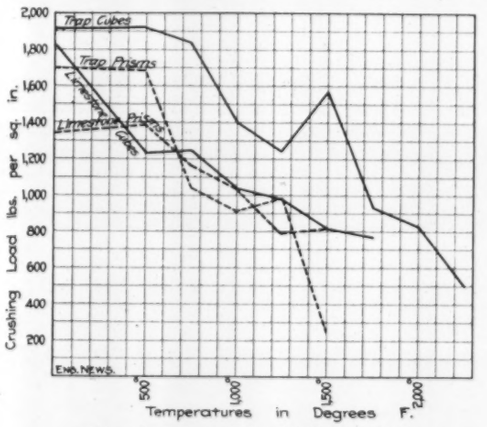


Fig. 6. Curve of Crushing Strength.

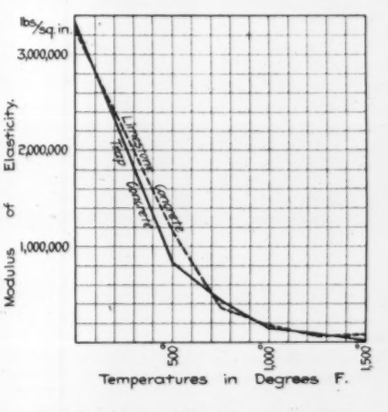


Fig. 7. Curve of Modulus of Elasticity.

FIGS. 6 AND 7. VARIATION OF CRUSHING STRENGTH AND ELASTICITY OF CONCRETE WITH TEMPERATURE OF PREVIOUS HEAT EXPOSURE.

Test pieces 4-in. cubes, 6 × 6 ins. × 14-in. prisms; all of 1:2:4: concrete.
Curves of Elasticity give the Modulus at Unit Stress of 200 lbs. per sq. in.

*The individual sets of curves are not reproduced here, as the grouping given in Figs. 2 to 5 are sufficiently representative of the results. The "true elastic" curves of all prisms tested are given in Figs. 4 and 5.—Ed.

TABLE V.—Compressive Strength and Modulus of Elasticity of Limestone Concrete Prisms.

Specimen No.	Age in Days. Before Heating.	Between Heating and Testing.	Heated to Degrees F.	Ultimate Strength in lbs. per sq. in.	E at 200 lbs. per sq. in.	E at 600 lbs. per sq. in.	E at 1,000 lbs. per sq. in.	Condition After Heating.	Specimen No.
5....	30	....	....	1,427	3,000,000	1,715,000	1,028,000	.....	5
6....	30	....	....	1,452	3,340,000	2,330,000	2,080,000	.....	6
7....	30	....	....	1,246	2,500,000	1,715,000	1,390,000	.....	7
8A...	44	4	500°	1,568	700,000	352,000	476,000	Specimen in good condition.....	8A
9A...	44	4	500°	1,207	1,330,000	1,176,000	972,000	Same.....	9A
14B..	45	7	750°	1,110	500,000	333,000	344,000	Not smooth on sides.....	14B
15B..	45	7	750°	1,214	222,000	294,000	286,000	Good condition.....	15B
18C...	51	4	1,000°	932	157,000	200,000	.....	Stone on edge slightly calcined	18C
19C...	51	4	1,000°	1,145	172,000	285,000	.....	Same.....	19C
22D...	57	3	1,250°	840	92,500	13,650	.....	Stone entirely calcined to depth of 2-in.....	22D
23D...	57	3	1,250°	740	59,000	10,000	.....	Same.....	23D
24E..	57	19	1,500°	....	....	....	.....	Stone entirely calcined, sides warped and shattered.....	24E
25E..	57	19	1,500°	810	83,300	133,000	.....	Same as 24E to lesser degree.....	25E

TABLE VI.—Period of Heating the Test Specimens.

Specimen.	Heated to Degrees F.	Time.
4-in. cubes.....	500°	55 minutes.
"	750°	1 hr., 35 min.
"	1,000°	2 " 15 "
"	1,250°	2 " 55 "
"	1,500°	2 " 55 "
"	1,750°	3 " 35 "
"	2,000°	3 " 55 "
"	2,250°	4 " 35 "
Prisms	500°	55 minutes.
"	750°	1 hr., 25 min
"	1,000°	1 " 55 "
"	1,250°	2 " 25 "
"	1,500°	2 " 55 "

ployed in the tests, and it was found that by allowing 1 hr. 15 mins. to bring the furnace temperature up to 750° F., and then holding that temperature constant, it required 2 hrs. 40 mins. more for the interior of two different prisms to attain the same temperature. Then raising the furnace temperature to 1,000° in 30 mins., it required 1 hr. 10 mins. more for the prisms to become uniformly heated throughout. The tests were made by imbedding thermo-couples in the middle of the prisms, and connecting them by switch to the same galvanometer on which the couple in the furnace was recording. The concrete on which this test was made was 28 days old. In this instance it required 5 hrs. 35 mins. to obtain a temperature of 1,000° F. through 3 ins. of concrete where the specimen was surrounded by heat on all sides, with no radiation possible.

This last experiment proved that the concrete had a very low conductivity and made certain the fact that the prisms tested had not been heated throughout to the temperature with which they are credited. At the same time, the writer believes, it explains the apparent discrepancy which exists between the results of these tests and some very satisfactory fire tests which have been made upon full sized floor constructions. In a test of the latter character the fire is applied to one side only, and, although a heat of 1,700° to 2,000° is maintained for four hours, the concrete is such a poor conductor of heat that only a small portion of it ever reaches a temperature which would cause it to deteriorate to any great extent.

The writer is fully aware that the data presented are very incomplete and by no means sufficient upon which to base conclusions. The problem is an extremely difficult one, and at the same time very important. He plans to continue the investigation as opportunity offers and hopes that other investigators will give it their attention so that in the near future some really reliable data may be obtained.

The investigation of this subject, together with the experiments detailed, in this paper, was undertaken at the request of the Joint Committees on Concrete and Reinforced Concrete of this Society, and forms part of the broad inquiry into the properties of that material which is being conducted in the various testing laboratories and technical schools of the country, under the general supervision of that Committee.

The actual work of the investigation, together with the calculations and plotting of the curves, was done under direction of the writer by Messrs. F. H. Burch, Jr., and W. H. Connell, Jr., two students in the Department of Mechanical Engineering at Columbia University, and formed the subject of a research thesis problem in their senior year. Much credit is due these men for their faithful devotion to the work, and their energy in performing the tedious details. The presentation of this paper at this time was made possible only by their conscientious assistance.

THE POPULATION OF CHICAGO was practically 2,000,000 at the middle of the present year, according to the method of computing populations used by the U. S. Census Bureau. This method is to assume that the yearly or monthly arithmetical rate of increase between 1890 and 1900 is continued through the next ten years. On this basis the present midyear population of Chicago is 1,980,750.

PERMANENT WAY AND STRUCTURES OF THE TOLEDO URBAN AND INTERURBAN RAILWAY.

By John S. Worley.*

The high standard of construction practiced on the better interurban electric railway lines now being built in the United States, is excellently illustrated by the short line known as the Toledo Urban & Interurban Ry. recently completed out of Toledo, Ohio. This road forms the completing link in a line some 60 miles long, and the circumstances leading to its projection and subsequent construction may be briefly described as follows:

The electric railway which is now known as the Toledo, Bowling Green & Southern Ry., is a road of about 60 miles in length, having Toledo as one terminus and Findlay, Ohio, as the other. Construction work was started in this line in 1901, and it was completed from Bowling Green, Ohio, to the west corporate line of Perrysburg, Ohio; at which point it connected with the Toledo & Maumee Valley Electric Ry., using its tracks into the city of Toledo, a distance of 10½ miles. Later the road was extended from Bowling Green to Findlay, but still maintained the trackage agreement as to entering the city of Toledo. This contract did not prove satisfactory at the beginning, but as traffic increased, and it was desired to shorten the schedule between Toledo and Findlay, it became more and more unsatisfactory.

As has been the common practice in the construction of nearly all electric roads, this line was built for as small a first cost as possible. It was fortunate to having competent engineering in the first part of its location and construction, but later this was dispensed with and the remaining part was built with scarcely any supervision at all. At the present time there are parts of the line which will have to be rebuilt before anything like fast trains can be operated. After changing from one corporation to another several times, the road at last became the property of its present owners who are also the promoters and owners of the Toledo, Urban & Interurban Ry.

In the spring of 1903, it became evident that the time was drawing near when the Toledo, Bowling Green & Southern Ry., owing to its increased business and the necessity of giving its patrons better service, would have to have, as far as possible, an independent line into the city of Toledo. The franchise of the Toledo Railway & Light Co., the street railway monopoly of Toledo, gives it the exclusive right to all the streets for electric railway purposes, thus compelling the interurban lines to contract for use of their tracks into the city. The only thing that can be done in case of this kind is to build the interurban lines over private right of way to as near the heart of the city as possible, and then connect with the city car lines.

In the summer of 1903, the directors of the Toledo, Bowling Green & Southern Ry. decided to build a connecting line from Perrysburg to Toledo. Realizing the magnitude of the undertaking, and the importance of future development, and profiting by the experience of previous construction without competent engineering services, they employed the firm of Riggs and Sherman Co., Civil and Consulting Engineers, giving it authority to locate and build such a road as it was thought the present traffic and its future development warranted.

An extensive study of eastern Indiana and western Ohio was made, which showed that section to be one of the richest in the country and the development of interurban railways good. Many of the Indiana electric roads were pushing out their lines toward western Ohio, while in Ohio the cities of Cincinnati, Columbus, Dayton, Springfield, and many of their surrounding villages were connected by trolley, the city of Dayton alone having fourteen interurban railways. The work of development was furthermore being pushed toward the north, and it seemed only a short time until these lines would connect with Toledo and Detroit. When this came about, it would be necessary to operate limited cars from these towns to Toledo in order to meet the demands of the patrons, and such traffic would necessitate a first class road bed and equipment.

An examination of the Toledo, Bowling Green & Southern Ry. showed it to be running nearly due south from Toledo, and in a direct line from there to the already developed interurban railway district. With the relocation of from eight to ten miles of the old line it could be made efficient for fast cars, and upon the development of a Cincinnati, Toledo and Detroit Electric line, it was so located as to become an important factor in that system. Such was the outlook of the interurban railways from the south with regard to Toledo in 1903. But one conclusion could be reached concerning the building of the connecting link of the Toledo, Bowling Green & Southern Ry. from Perrysburg to Toledo, and that was that its location and construction should be the best. This con-

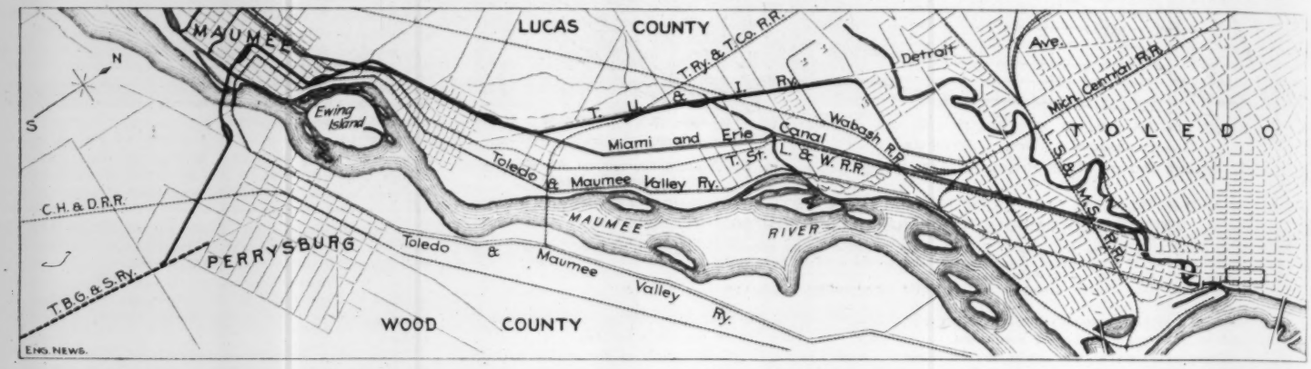
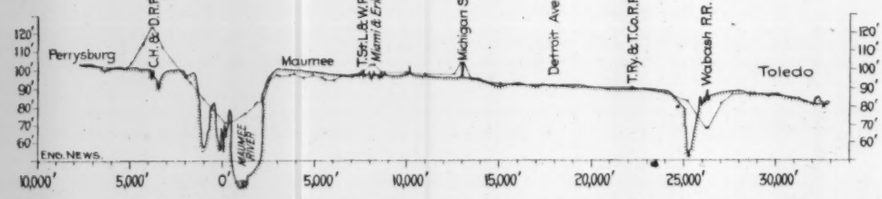


FIG. 1. MAP AND PROFILE OF TOLEDO URBAN & INTERURBAN ELECTRIC RAILWAY.



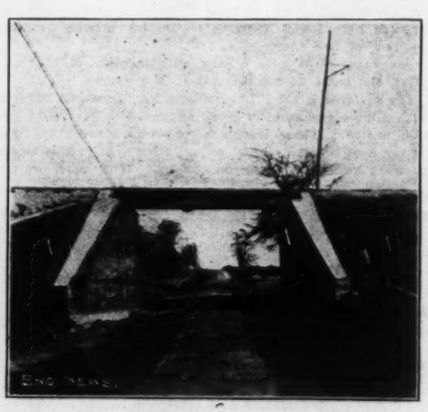


Fig. 3. Typical Overhead Crossing of Street, Toledo Urban & Interurban Ry.

*The Riggs & Sherman Co., 613 Nasby Building, Toledo, Ohio.

necting link is what is known as the Toledo, Urban & Interurban Ry.

ALINEMENT AND GRADES.—After an exhaustive survey of all that country on both sides of the Maumee River, which lies between Perrysburg and Toledo, it was decided to turn north just west of the corporate line of Perrysburg, cross the Maumee River at Maumee, pass through that village and cross the Miami and Erie Canal. After crossing the canal to follow along its north bank to Detroit turnpike, and then parallel that highway into Toledo until a connection could be made with the Toledo Railways and Light Co.'s tracks. The location is shown by Fig. 1.

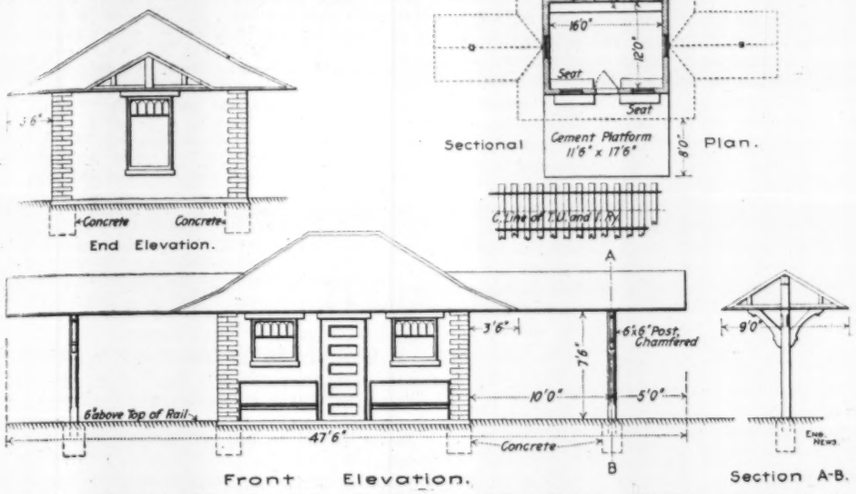


FIG. 2. DETAILS OF CONCRETE BLOCK SHELTER HOUSES, TOLEDO, URBAN & INTERURBAN RY.

Much study was given to the topography of the country, in order to obtain the best possible alinement, as well as the most economical route. After a number of preliminary surveys, the final location was made with a maximum curvature, outside the village of Maumee, of 10°, and in this village, on turning the corners of blocks, the corner lots were purchased and the line located so as to get a maximum curvature of 22°. The total length of track is 7.7 miles. The total degrees of curvature is 496° 06", of which 246° 15' are in the village of Maumee. The total length of curvature is 1.37 miles or 18% of the whole length of track.

In the establishing of the grade line especial attention was paid to the separating of the grades at the crossings of the Cincinnati, Hamilton & Dayton Ry.; the Toledo, St. Louis & Western Ry., the Toledo Railway & Terminal Belt; the Wabash Ry. and the Maumee Waterville Electric Ry. It was thought that tthe separation of grades of interurban electric roads with steam roads, was just as important as the separation of grades of steam roads with steam roads. The state laws of Ohio require derailing switches at all such crossings, thus causing much delay in addition to the danger of grade crossings. Two of these crossings the C. H. & D. Ry. and the Wabash Ry. were of such importance, and the ease with which the Maumee & Waterville Ry. permitted a separation was such that three of the five grade crossings were eliminated. For the other two, it was thought best to have grade crossings at present, but a subsequent separation is recommended. These grade separations necessitated the use of 2% grades. There is only one other grade greater than this and that is in the village of Maumee, where a 2.83% grade was necessary for a distance of 400 ft. in order to conform to the surface of the street. Advantage was taken of the topography in locating this road by laying the grade line so as to eliminate four important highway crossings. The difference of the elevations of the highest and lowest points in the grade line is 53½ ft., of which 26½ ft. is due to grade separations at railway crossings.

ROADBED AND TRACK.—In the construction of the roadbed, the specifications called for 14 ft. width of crown on fills, and 18 ft. width of base in cuts. In the village of Maumee the roadbed was excavated to a depth of 1 ft. below the bottom of the ties, after which a ditch was dug in the center and an adequate tile drain laid. The whole was then filled with broken stone to the top of the ties, and top-dressed with screenings to a level with the top of the rails. All the tracks in Maumee have excellent sub-drainage.

The ties used in the construction of this road are 6 × 8 ins. × 8 ft. white oak ties, and are spaced 17 to the rail length of 30 ft. The rail laid in the village of Maumee is 6 in. shanghai connected up by special angle bars, while all other rail is 70 lb., American Society of Civil Engineer's section, having four hole "Weber" joints. Seven-eighth inch "Morris" bonds are concealed beneath the joints These bonds are placed in both rails, and all bonding was done immediately after the bond hole was drilled in order to obtain as perfect contact as possible.

Of special rail work, there are two railway crossings of the best pattern, having easier rails, etc. On the electric line, 75 ft. on each side of these crossings, there are low lever, spring point, derailing switches, which are so arranged that the points have to be held closed while the car is passing toward the crossing, but can be trailed on leaving it. There are five passing tracks within the 7.7 miles; one is a double diamond spring point, the other four are sidings. These latter have No. 10 spring frogs and high switch stands operating spring points, which can be trailed on passing to the main track.

Under the track is placed an average of 10 ins. of limestone ballast, which is brought to the top of the ties, their whole length, and then sloped off at the ends. Much of the rumbling noise made by cars is eliminated when the space between the ties is completely filled.

Outside the village of Maumee a 50-ft. right of way was obtained, and the line was located on one side, giving an opportunity in the future for double tracking such parts as might be desired. This right of way is enclosed by a 5-ft. woven wire fencing, tacked to cedar posts, and ordinary slide gates are provided for entrances to the adjoining farm roads. The crossings to these lands are made of four 4 × 12 ins. × 16 ft. oak plank, one spiked each side of the rail, and of broken stone placed on the approaches. Patent clay cattle guards are used and are found quite satisfactory.

Signs 6 × 30 ins. designate the names of all streets and highways, all bridges have warning signs at each end, and all railway grade crossings and bridges have signs placed 500 ft. on each side of that point or structure, calling attention to their nearness.

Places along the highways which have become dangerous for teams owing to the electric line crossing or paralleling the roadway, are protected by a guard fence on one or both sides, as the occasion demands. These protection fences are built of 9-ft. posts spaced 8 ft. apart with a 2 × 12-in. plank at the hub line and capped 4½ ft. from the ground with a 4 × 6-in. oak piece.

SHELTER HOUSES.—The comfort of the people while riding over a good roadbed was not the only one which was held in mind in constructing this road. The winters in this part of the United States are about six months in length, and to have to stand out in rainy or snowy weather while waiting for a car, is one of the most disagreeable things that interurban passengers have to encounter. Many of the interurban lines make use of their old cars for shelter houses, but they soon become so dirty inside that people prefer the cold to the filth. Along the line of the Toledo, Urban & Interurban Ry., at all points where the traffic warranted, good shelter houses of concrete blocks have been erected. These houses are 12 × 16 ft. inside dimensions, and have a 9 × 15 ft. porch at each end, as shown by Fig. 2. The roof is made of bark-colored cypress shingles, having a 3½ ft. projection on all sides, while the floor and platform is concrete. The building is provided with six large windows and a heavy panel door.

Inside along the walls and outside under the projecting roof, are placed ordinary oak station room seats. These shelter houses not only add much to the comfort of the patrons of the road, but are also a great improvement, in appearance, to the old tumble-down cars ordinarily used.

BRIDGES.—That one thing along a railway, which is an exponent of the whole, is the character of its bridges; bridges being a term used in a broad sense covering the structures of all kinds which span the waterways and other openings. In the construction of the Toledo Urban & Interurban Ry., these structures are in perfect harmony with the remainder of the road. In a few instances, for small cross drains, double strength vitrified pipe are used; openings requiring larger area are spanned by concrete-steel box culverts, and still larger ones, either by concrete arches or abutments carrying steel eye-beams for stringers, Fig. 3. In three overhead street crossings, concrete abutments were erected and steel plate girders used. One pile trestle was erected where later it is expected to make a high fill, using a train of dump cars to haul the material. The Miami & Erie Canal is crossed by a 98-ft. plate girder drawbridge.

The overhead crossing of the C. H. & D. Ry. is one of the most important structures along the whole line. This crossing consists of 505 ft. of pile trestle approach on the north, 250.8 ft. of steel viaduct over the C. H. & D. Ry. and Eighth

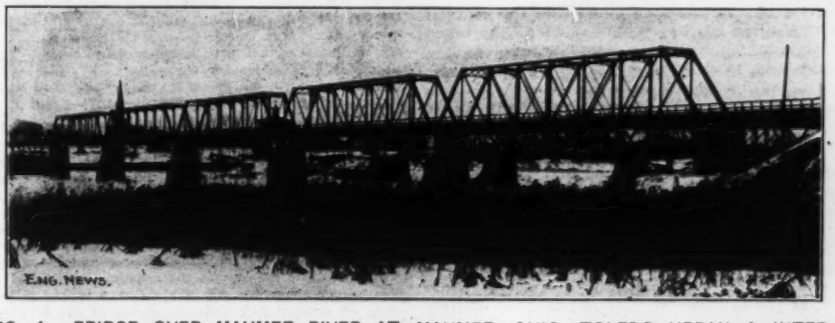


FIG. 4. BRIDGE OVER MAUMEE RIVER AT MAUMEE, OHIO, TOLEDO URBAN & INTERURBAN RY.

Street of Perrysburg, and 279 ft. of pile trestle on the south side. The pile trestle approaches are of the standard railway type. The steel viaduct consists of a 32.2-ft. girder span, and a 21-ft. girder span built into a tower, connected to this and spanning the C. H. & D. Ry. to another tower, is a 63-ft. through girder, followed by two steel towers and a rocker bent spaced 31.2 ft. apart and supporting plate girders. The outside ends of the two end girders each rest on two bents of piling capped by 12 × 12 in. × 12 ft. timbers. The clearance over the C. H. & D. Ry. is 21 ft.

The bridge across the Maumee River, at Maumee, shown by Fig. 4, is the most pretentious structure on the road. It is 1,378½ ft. in length, and the bottom of the floor system is 35 ft. above the normal water surface of the river. The bridge is approached, on the south side, by a long fill, and on the north side, by 139 ft. of frame trestle on piling and a 225 ft. of fill, which brings the track up to the grade of the first street intersection in Maumee.

Beginning at the south end, the bridge consists of a 40-ft. plate girder, then five 162½ ft "Pratt" through truss spans, followed by 525 ft. steel viaduct built of alternate steel towers and bents supporting plate girders. The through truss spans are placed on concrete-steel piers, the towers and bents of the viaduct are on concrete pedestals, and at each end there is a concrete abutment.

The through spans are built on a 0.55% grade, while that of the viaduct is 1.23%. It is by the means of this viaduct that the grade crossing of the Waterville & Maumee Electric Ry. was eliminated. Along the down-stream side of the bridge is a 3-ft. walk, having a guard rail on the outside. The metal is painted with two coats of dark green graphite paint. This bridge was designed for a live load of 200 lbs. uniform and 20,000 lbs. concentrated load, and 1,300 lbs. dead load per lineal foot of bridge.

The separation of grades with the Wabash Ry. was accomplished by means of a subway, which contained, approximately, 20,000 cu. yds. of earth. The Wabash Ry. has a double track at this point, and the two lines cross at an angle of 25° 55'. Before any excavating could be done it was necessary to erect two pile bridges of 150 ft. length each, requiring the driving of 115, 35-ft. piles their full length, which was done in a little less time than ten days. This was rather a difficult task as the Wabash Ry. would not even do so much as issue a slow order to any of their trains for this place while the work was being executed. These pile bridges are still in place, but during the coming summer are to be supplanted by steel through girders on concrete abutments.

The subway is 1,800 ft. in length and has a maximum cutting of 21 ft. The track approaches the Wabash Ry. on a 1.50% grade from one side and a 2.00% from the other. It is very thoroughly drained by two rows of 6-in. tile placed in 2-ft. ditches on each side of the track, these ditches being filled with broken stone. The tile connects with 500 ft. of 24-in. sewer built specially to drain this cut. There is a width of 18 ft. at the base, and the slopes are 1 to 1. The track is placed on 1 ft. of stone ballast which extends from slope to slope, thus facilitating the drainage and securing a perfectly dry roadbed.

All construction work, excepting the abutments and steel bridge of the Wabash Ry., was completed by Jan. 31, 1905, and trains began operation Feb. 1. It was soon found that the running time, from Findlay to Toledo could be shortened 30 minutes, and the annoyance of often having cars behind their schedule, owing to the congestion on the Toledo & Maumee Valley Ry., was done away with.

At this time, March, 1905, the connecting link is being projected from Lima to Findlay, which will connect Detroit, Cleveland and Toledo; with Columbus, Springfield, Cincinnati and Indianapolis, and the Toledo, Bowling Green & Southern Ry. with the Toledo Urban & Interurban Ry. will become one of the most important parts of the great trolley system of Ohio and Indiana.

Although the cost, per mile, was nearly triple that of the ordinary electric railway, the officials of this road are exceedingly pleased with its high standard of location and construction.

SEMI-ANNUAL MEETING OF THE AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.

The summer meeting of this society was held at the Auditorium Hotel, Chicago, on July 7 and 8. In the absence of the president and both vice-presidents, Mr. J. H. Kinealy was elected chairman of the meeting.

RESIDENCE HEATING BY DIRECT AND INDIRECT HOT WATER.—This paper, by Mr. E. F. Capron, described the installation in a large residence, heated by 2,518 sq. ft. of direct and 1,200 sq. ft. of indirect surface, with 285 sq. ft. in the tempering chamber. The most important part of the paper was a tabular record of the temperatures of the outside air, the water, and the various rooms, with the amount of fuel consumed, and one of the speakers in the discussion urged that such papers were extremely valuable as showing actual results. The discussion turned mainly on the relative merits of locomotive firebox boilers, as used in the building in question, and cast-iron sectional boilers. Mr. Capron preferred the former and stated that they are much used in the West. Mr. Harvey spoke of the unsatisfactory experience with locomotive boilers in a railway building. When a new roundhouse was to be heated he took one of these boilers and built a brick setting, with furnace under the shell; the products of conbustion passed back to the firebox, then through the tubes and then back along the top of the boiler to the chimney. With this arrangement the efficiency was very much higher than when the boiler was fired in the usual way.

FLOW OF AIR IN METAL PIPES.—This paper, by Mr. J. H. Kinealy consisted mainly of formulas and tables, with examples explaining their use in the design of heating systems.

THE DESIGN OF CENTRAL STATION HOT WATER HEATING SYSTEMS.—In this paper Mr J. D. Hoffman briefly noted the growing field for central station heating, and then described in detail the method to be followed in the design of an individual plant, with the several conditions entering into consideration. We shall publish an abstract of this paper. A written discussion from Prof. Wm. Kent was read, suggesting the compression of exhaust steam to force it into the mains, but the oral discussion turned largely on the financial results of central station heating plants. It was pointed out that these results are very difficult to determine, as in most cases they are combined with the results from electric lighting operated from the same plant.

DRYING BY STEAM, HOT AIR AND WASTE GASES.—This paper was by Mr. H. J. Barron, and largely discussed the physics of the absorption of moisture, but we give an extract below as to the application of the process:

In any drying problem, the important fact is to get the saturation of the material, the amount of water per pound or per ton which it contains; then figure the number of heat units necessary to vaporize this moisture, which approximates the latent heat of steam at 212°, 965 B. T. U. per lb. of moisture; and then supply a volume of air containing these heat units which will absorb the required volume of moisture or water.

Some lines of drying, like laundry and lumber drying, have become stereotyped and the lines of practice are well established. Other lines are in the experimental stage and new developments in manufacture are constantly bringing up new problems. Much time and money have been spent in experimenting with brick drying in connection with machine brick making. Until recently, large massed box coils were placed in the bottoms of the tunnels and the brick cars were passed over them. High-pressure steam was used in the coils and the tops of the tunnels had ventilators. This was supplemented by exhaust fans forcing in air at the wet end or entrance. At the present time, brick drying is almost entirely hot blast, a blowing fan and stack forcing hot air into the tunnels.

The drying-rolls of paper making machines are generally enveloped in a hood, which is usually fitted with two 48-inch disk or propeller fans capable of exhausting from 30,000 to 40,000 cu. ft. of air per minute. In cold weather, air is forced into the machine room at a temperature of about 90°, so that we have in the machine room of a paper mill what is considered the best practice to-day in heating and ventilating; namely, hot air forced in at whatever temperature is required and local ventilating fans exhausting air wherever necessary to meet special conditions.

In brick drying and in some other lines of industry a similar nature where there are kilns which waste gases of high temperature, these gases are taken up by a fan and forced through the drying tunnels or rooms. Such fans are employed for exhausting and giving a thorough circulation to the waste gases. In drying lumber, part of the moist air is returned to be reheated, while the very wet air is forced out of the loading end. If the lumber has been previously partially air dried, there is some saving in returning a part of the air from the fan to the heater. It usually takes a week to dry ordinary 1-in. stuff, such as yellow pine. The essential principle in all drying are large volume of air and not particularly high temperature. This is why open air sun drying is so satisfactory. In lumber drying the moisture vaporizes and passes off, but if the temperature is too high the resin in the wood will harden and, bursting from expansion, will cause checking of the wood. Where this does not do this, it is apt to leave the lumber non-elastic and brittle. The moist air which is returned is often blamed for causing this condition and also for stained the lumber.

In drying wool, cotton, silk, jute, pine fiber, rubber, etc., the material should be placed in a bed made of wire screen of almost any mesh. The screen is kept in constant motion and large volumes of air passed through it. The screen is so arranged that all the air must pass through it.

The engineer sometimes requires a closed air heater to utilize waste gases for drying purposes.

POSSIBILITIES IN HEATING WITH HOT AIR.—In this paper Mr. R. S. Thompson presented the advantages of this system as compared with steam or hot-water systems. The paper is printed nearly in full on another page of this issue.

SHEET METAL RADIATION.—This short paper by Mr. H. W. Nowell presented the advantages of radiators made of sheet iron as compared with those of cast iron. Some of the members had had trouble with the corrosion of sheet metal radiators, but Mr. Nowell spoke of some which have been in use for 39 years. He uses black iron of special quality, coated on both sides with an aluminum spelter to prevent oxidation, and the sections are put together with expanded joints, under heavy pressure, no solder being used.

TOPICAL DISCUSSIONS.—There were a number of topics for discussion listed on the program, but only a few of these were considered.

1. Can Size of Pipe for Risers and Radiator Connections from Risers be Reduced?—The first speaker considered that there is a tendency to use pipes larger than necessary; and was supported in this view, although one member suggested that the object was to reduce back pressure. A resolution was adopted recommending that the Society investigate the matter and prepare a table of sizes suitable to different conditions.

2. Can Area of Mains in Overhead Systems of Hot-Water Heating be Reduced with Benefit?—Mr. W. M. Mackay thought that such a reduction could be made.

3. The Protection of Underground Piping.—Different methods of conduit construction for the insulation and protection of steam and hot-water pipes were described.

4. The Benefits of Large Mains with Branches in Hot-Air Systems.—The idea suggested was that instead of using a number of individual mains from the furnace, it is better to use trunk mains with branches.

5. A Vacuum System of Hot-Water Heating.—Mr. White described a system which he has used, the advantage of which is largely in improved circulation with a low fire in the boiler.

6. The Production of Wrought Iron Screw-Nipples.—The machines used for making these nipples were described, and it was suggested that the Society should investigate the better design of nipples.

7. The Ventilation of Public Buildings.—This discussion related to a proposed bill providing for the proper ventilation of schools and other public buildings in Illinois. This requires the admission and the exhaust of 30 cu. ft. per minute for each person. Mr. Mackay gave a brief review of the similar laws in New York, Pennsylvania and Massachusetts.

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The newspapers are quoting various distinguished railway officials in defense of the theory that high-speeds for railway trains are no more dangerous than ordinary speeds. Of course so long as high-speed trains are run, railway officials cannot consistently characterize them as dangerous; but the arguments presented to prove the safety of high speed must have required great ingenuity to evolve. A notable example is the following quotation from a N. Y. "Herald" interview with Vice-President W. C. Brown of the New York Central & Hudson River R. R.:

Reporter: "Did you ever hear of an accident occurring on a railway directly attributable to high speed?"

Mr. Brown: "No. I never did. I doubt very much if such an accident ever occurred. I do not see how it could occur. The engineers and the operating and the mechanical departments have made such a careful study of what a train can do over each yard of roadbed that they know exactly where the danger line is. Of course, they keep well within it."

The fallacy that there is a hard and fast line between safety and danger is a very common one. Actually, however, it is as impossible to say where safety ends and danger begins as to say at what velocity slow speed changes to high speed. Safety and danger, like fast and slow, are relative terms. No one is wise enough to say at what exact speeds railway travel ceases to be safe and becomes dangerous over a particular section of track; but it takes only a moderate amount of practical common sense to perceive that the danger does increase with the increase of speed, or to put it the opposite way, that railway travel is safer with trains run at slower speed.

A very curious defense of the high-speed trains is that they are safer to travel in because greater precautions are taken for their protection. To quote again from the "Herald" interview with Vice-President Brown:

"I consider that this eighteen-hour train from New York to Chicago is the safest railroad train in the world."

"Why?"

"Simply because everything gets out of its way. The line is made clear for it and every possible precaution is taken to make its run successful and pleasant. There is no danger of anything or any other train running into it from the rear and trains ahead of it are sidetracked and held until it passes. The chance of an accident on the eighteen-hour train in my mind is at least 50% less than on any other train."

So far as this may be true, it appears to us a rather severe indictment of American railroading. If it is correct that precautions are taken for the protection of this train that are not taken for ordinary express trains, it is quite in order for the traveling public to inquire why equal care is not taken of the trains on which it has to ride.

And the inquiry is an entirely proper one. Why should the train dispatcher, the signal tower men, the station agents and the whole operating force be ordered to display unusual diligence for the protection of this particular train? What precautions can they take which they ought not also to take for the benefit of other express trains? What may they neglect with ordinary trains that they do not neglect for this train?

It is probably true that on many American railways the operating staff is more or less imbued with the idea that one or two crack trains are to have the benefit of especial watchfulness; but we believe this is a wrong basis on which to raise the standard of safety in American railroading. The idea to inculcate in every employee on whom the safety of train movement depends is that all trains are equally entitled to his unremitting care and watchfulness. To tell a man to use unusual care for a particular train is almost equivalent to telling him that he may somewhat relax his vigilance after that train has passed.

New York's "original skyscraper" has been marked for demolition. According to the newspapers it has been decided to tear down the Tower Building erected sixteen years ago, and to build on its site on lower Broadway a modern 20-story structure to cost a million and a half of dollars. This is not the first tall building that has been razed to meet the exigencies of metropolitan development but in the only previous instance the demolition was not solely for the purpose of making room for a greater structure of the same type nor did it affect a structure historically so important.

The Tower Building was completed in the Fall of 1889, after designs by Mr. Bradford Gilbert and was a true skeleton structure in the sense that the walls and floors were carried entirely by the metal framework. Compared with more recent buildings of its type it is a pigmy, being only ten stories high, but in its day it was a landmark in downtown New York. It and the Home Life Building in Chicago, designed by Mr. W. L. B. Jenney and built in 1884, were the first of the great family of many-storied structures which today dominate the business sections of every large American city. At the present time when the tall building is taken as a matter of course, it is interesting to reflect that the original skyscraper of New York's scores of tall buildings began construction only 17 years ago, and that when the designs were submitted to the Building Department there was considerable doubt on the score of safety as to the wisdom of sanctioning them. The plans were ultimately approved, however, and for New York they marked a new era in office building construction which is yet too recent and too familiar to our readers to need description.

The new 20-story building which is to replace the Tower Building marks the advance which has been made in 17 years in tall building construction. Of course much taller buildings can be and have been constructed—the present Park Row Building is 30 stories high and the proposed New York "American" Building has been planned to have 40 stories—but commercially a building of from 16 to 20 stories represents fairly modern tall building practice. Such a structure as the new "American" Building can be regarded only as a *tour de force*, warranted, perhaps, for advertising purposes, but not as a particularly economical structure for renting purposes. It is too early as yet to say in what other respects than height the new Tower Building will mark the advance of years in tall building construction when compared with the structure which it replaces. One thing that we may be sure of is that the cast-iron columns of the old structure will have no consideration in designing the new building. Other differences there will be, some of them very marked ones, but in none will the change recorded be so radical as the entire elimination from consideration of cast iron as a safe building material for skyscrapers.

A very remarkable and important improvement in incandescent lamps was made public at the recent Asheville convention of the American Institute of Electrical Engineers, and is described in a paper printed elsewhere in this issue. As is well-known, the chief drawback of the incandescent lamp as a means of illumination is the amount of current which it consumes. It is this that makes a market for such inventions as the Nernst lamp, notwithstanding the inconvenience in its use, or the Cooper-Hewitt mercury lamp, notwithstanding its ghastly green color.

It is now announced that by a comparatively simple method the filament used in the ordinary incandescent lamp can be so treated as to give out a greater quantity of light when heated by a passing electric current. Expressed in figures, an ordinary incandescent lamp of high efficiency gives a candle-power for about 3.1 watts of current. The improved lamp gives a candle-power for 2.5 watts. Thus, for the same expenditure in central station, distributing system and operating expenses, there will be produced about 20% more light; or a kilowatt of current will produce 400 c. p. of light instead of about 320, as at present.

The importance of such an improvement in increasing the field of incandescent lighting is obvious.

The value of an engineer's work is something which is often discussed. We have seldom seen it stated in a more business-like way, however, than in a little pamphlet recently issued by a well-known engineering firm in Cleveland, O. The pamphlet was issued to set before prospective clients the advantage arising from the employment of competent and experienced engineers to supervise the construction and operation of electric railway, light and power plants. This is the argument which is put forth for the engineer:

WHY DOES IT PAY TO EMPLOY A COMPETENT ENGINEER?

1st. Reduction of first cost, including the avoidance of "extras."

2d. Reduction of operating expenses because:

(a) The desired results are obtained with maximum economy of labor, fuel and supplies.

(b) Repairs are a minimum.

(c) Depreciation is a minimum.

To what extent will it pay?

On first cost it will probably save from one to three times the cost, possibly more.

On operation, including repairs and depreciation, the result of the best design and supervision of construction, as compared with haphazard or mediocre engineering, is a saving of 20% to 30%, or more, of the amount paid the engineer. This is the direct saving, but, because of the greater reliability, the direct gain is incalculable.

Therefore, upon basis No. 1, if the engineer saves in first cost an amount equal to his charges, his employment is justified; a greater saving is profit; and, upon basis No. 2, he will also directly save annually 20% to 30%, or more, interest on his charges besides the indirect saving stated above.

The net result is a dividend on the engineer's charges of 100% or more, at the start; and 30% or more, annually, during operation.

What other investment pays at such a rate?

The use of compressed air for shaft sinking or tunneling was at one time regarded as a last resort—an extreme measure to be adopted when others had failed. Due to the persistence of beliefs, once they have gained general acceptance, compressed air has not been used so extensively as it will be in the future, and as it deserves to be used at present. Elsewhere in this issue Mr. F. I. Winslow describes the construction of an 8-ft. tunnel, only 100 ft. long, at Boston. Both in sinking the shafts and in driving the tunnel, compressed air was used without the use of a shield. Due to the light air pressure—24 lbs. and less—long shifts were worked without injury to the men.

Such work as this should be very suggestive to engineers and contractors having deep sewers to build in soft ground. Often the attempt is made to build a large sewer in a deep open trench, requiring a great expenditure of money for bracing, for pumping, for excavating, for backfilling, and for repaving, to say nothing of the inconvenience and loss to those who have to use a congested and torn up street. We believe that as it becomes more generally known that compressed air is not a dangerous and mysterious agency for tunnel

work there will be fewer deep trenches in wet ground and more small tunnels. We shall welcome any further contributions on the ways and means of doing this kind of work, and particularly any data showing rates of progress and size of working force. Many large tunnels have been described, but there is singularly little in print on the driving of small tunnels in soft ground.

The modest little paper on "Possibilities in Heating With Hot Air," reprinted in this issue, is worth the serious attention of readers having any interest in house-heating problems. We believe the author is entirely correct in his advocacy of hot-air heating as the ideal method for buildings of moderate size, not too much cut up in separate rooms. For such buildings a hot-air system can be installed at a cost only a fraction of that of a steam or hot-water system; it can be maintained at a similarly small proportionate expense, and it can be run with less fuel consumption and less attention.

We say it *can* be, with full knowledge of the fact that the average hot air house-heating system falls far short of success. As the writer of the paper referred to truly says, however, the trouble lies with the manner in which the hot-air plant is installed and not with the system itself. Apply the same degree of common sense, the same knowledge of engineering principles and the same degree of workmanship to a hot-air heating problem that would be given to the design of a steam or hot water heating plant, and we believe the hot-air system—in buildings adapted to its use—will give much the best results.

COMMENTS ON TWO SPECIFICATION CLAUSES RELATING TO EXTRA WORK.

We have had occasion to criticise certain specification clauses relating to payment for extra work, because of their failure to define what was meant by the expression "actual cost plus 15%." The following clause from a recent sewer specification is, in this respect, the most definite of its kind that we have seen:

> Extra work ordered in writing by the Board or the engineer will be paid for at the reasonable and actual cost of the same plus fifteen per cent. for profit, superintendence and general expenses. The said cost of the extra work shall include all fuel, materials and labor furnished by the contractor, but it shall not include office expenses, general superintendence, salaries, use of tools or machinery or other general expenses.

There seems to be some doubt whether, under this clause, the cost of "bossing" the job is included or not. General superintendence is specifically excluded, but nothing is said as to foremen, unless we take the word "salaries" to include all men paid by the week in distinction from men paid by the day. Foremanship may itself run from 5% to 15% of the total cost of small engineering works, so that it is important to include it specifically in the items of "actual cost" to which the 15% is to be added. It is immaterial whether the foremen in charge of separate gangs of men are paid by the day, by the week or by the month, hence the word "salaries" if used at all in a specification should not be made to include the foremen who are bosses of individual gangs.

Now, a word as to the specified percentage to be added for profits. It has been the experience of a well-known contractor with whose records we are familiar, that on sewer work the "general expenses" (exclusive of foremanship) seldom amount to less than about 7% of the total cost, and that the wages (or salaries) of bosses will average another 10%.

The insurance of sewer laborers amounts to several per cent. of the payroll. Indeed, there are cities where the soil is so treacherous that surety companies fix premium rates that are practically prohibitive. One cave-in may wipe out several thousand dollars worth of premiums, by causing the death of a man.

We see, therefore, that there are conditions under which 15% added for profits, is in reality 15% added for expenses that are as actual as the weekly payroll. Each piece of work must be considered by itself, in specifying the percentage for profits, but in all cases the cost of foremen should be included.

Where an expensive plant is likely to be required, it may be desirable to specify a certain percentage of the first cost of the plant to be allowed for "plant rental," and considering this "plant rental" as an item of the "actual cost."

It will be noted that fuel is included as an item of "actual cost." This should always be done, as fuel is often an important item, and its cost is readily ascertainable.

As a minor criticism of the clause under discussion, we would suggest that the word "reasonable" be struck out. It adds nothing to the force of the clause, and in fact weakens it by introducing an indefinite and unnecessary word that might be used as an objection to payment for such extra work as might seem unreasonably expensive.

Having discussed a clause in which an honest attempt has been made to be definite, let us consider one that is vague in one important particular, but still possesses some merit. It also applies to sewer work, and reads as follows:

> The contractor shall do such extra work in connection with his contract as the engineer may direct in writing. It shall be done in a first-class manner, and under the same requirements as other work contemplated in the contract, at a price to be fixed by the estimate of the engineer. The estimate to be based upon prices named in the proposal and contract, or from material and force accounts, allowing 10 to 20% profit, according to the nature of the work. No claims will be allowed, however, for extra work, unless the same shall have been done in pursuance of the aforesaid written order, or the engineer shall admit ordering the work verbally, and failure to give the proper written order.

The phraseology of this last sentence is very poor. Moreover, a "written order" should never give way to a verbal order, even if a dozen engineers were to "admit" having violated the rule of procedure specified. Engineers too frequently destroy the force of a contract stipulation by failure to follow the procedure that they themselves have ordered. Let it be stated in every extra work clause that payment will not be made except for work ordered in writing, and let no exception to this rule be tolerated, if law suits are to be avoided.

The clause, it will be seen, is vague not only in that it does not specify what is to be included in the "actual cost," but in that it gives no exact percentage to be added for profits. To allow "10 to 20% profit according to the nature of the work" is not defensible on any ground. Why should the "nature of the work" affect the rate of profit allowed?

It is true that 10% profit on materials and 20% profit on labor might be a fair interpretation of this clause—then why not say so?

It is true that 10% "profit" where an inexpensive plant is used might be greater than 20% "profit" where a large plant is required—then why not name a definite allowance for plant rental dependent upon the value of the plant? So vague an expression as "10 to 20%, etc.," has no rightful place in a specification written by an engineer who is a student of economics.

Having condemned the last half of this clause, there appears to be little left to commend, yet that little is quite important. "The estimate is to be based upon prices named in the proposal and contract" is a phrase that will cover much of the extra work to be done under most contracts. Any work exceeding in quantity the amount shown in the plans or bidding sheet is certainly extra work. Now, is that kind of extra work to be paid for at bidding prices, or by force account plus a specified percentage for profits? The clause quoted at the head of this article is silent on this point, and to that extent it is defective, for a contractor might claim that every yard of material moved in excess of the specified yardage is extra work and must be paid for upon a force account basis. To avoid a law suit, the clause relating to extra work should be clear on this point; and, for that reason, the second clause has one feature, at least, in which it excels the first clause under discussion, although in all other respects it is inferior.

LETTERS TO THE EDITOR.

A Table of Turnouts and Crossings.

Sir: I send you herewith a blue print of a table of turnouts and crossings which I had made for use in the drafting room of the Chief Engineer's office, B. & O. R. R. It has proven very valuable in making studies and plans of yards, sidings, etc., as any desired functions can be quickly obtained by an inspection of the table.

All functions are calculated from given values, found in the first six columns, which conform to our standards and specifications for frogs and switches. You will notice that the calculations are based on the actual working point of frogs and switches, assuming these to be on tangents, making the table conform to the practical way of laying these out.

Lead in column 14 is based on the calculated lead in column 20, using the nearest half of foot, except in a few cases where the same lead is desirable for a series of frogs of the same number.

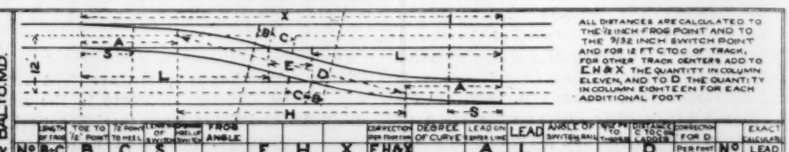
This table differs from most tables and text books on this subject, inasmuch as the calculations in them are based on the theoretical points, and assuming that the switch point and frog is on a curve. This table is sufficiently close for yards with curved leads, where the curvature is not excessive. Yours truly,

J. H. Milburn, Chief Draftsman.

Office of the Chief Engineer Baltimore & Ohio Railroad Co., Baltimore, Md., June 28, 1905.

TABLE FOR TURNOUTS AND CROSSOVERS ON TRACK FOR 4 FT. 8½ INS. GAGE.

BALTIMORE AND OHIO RAILROAD
TURNOUTS AND CROSS-OVERS GAUGE 4FT 8½IN
OFFICE OF THE CHIEF ENGINEER BALTO.MD.


ALL DISTANCES ARE CALCULATED TO THE ½ INCH FROG POINT AND TO THE 9/32 INCH SWITCH POINT AND FOR 18 FT C TO C OF TRACK. FOR OTHER TRACK CENTERS ADD TO E H & X THE QUANTITY IN COLUMN ELEVEN, AND TO D THE QUANTITY IN COLUMN EIGHTEEN FOR EACH ADDITIONAL FOOT

No	Length of Frog "a"	Toe to "a" Point	"a" Point to Heel	Throw of Switch	Frog Angle	E	H	X	E H & X	Correction for Position on Curve	Degree of Curve	Lead on Curve	Lead L	Angle of Switch Rail	No. of Rails	Distance C to C Tracks	Correction for D Per Foot	No	Exact Calculated Lead
4	8	3'-0"	5'-0"	11'-0"	3½"	14'-15.009	9.250	4.750	28.089	2.250	3.938	45°-55.38"	21.000	40°-0"	2"-15.51"	7/16	48.750	4.063	4	38.395
4½	8	3'-0"	5'-0"	11'-0"	5½"	12°-40.48	10.584	5.334	33.584	4.444	37°-50.00	20.125	41'-6"	2"-15.51"	7/16	54.667	4.556	4½	41.637
5	8	3'-0"	5'-0"	11'-0"	5½"	11°-25.16"	11.900	5.400	33.900	4.950	29°-48.38"	22.250	46'-0"	2"-15.51"	7/16	60.600	5.050	5	44.757
6	8	3'-0"	5'-0"	16'-6"	6½"	9°-31.39"	14.500	7.498	28.500	5.958	20°-38.57"	28.500	57'-0"	1°-47.56"	9"	72.498	6.042	6	56.891
6	8	3'-0"	5'-0"	15'-0"	6½"	9°-31.39"	14.500	7.498	28.500	5.958	20°-28.54"	25.500	54'-0"	1°-58.43"	8⅛	72.498	6.042	6	54.802
6	8	3'-0"	5'-0"	13'-0"	5½"	9°-31.39"	14.500	7.498	28.500	5.958	20°-05.04"	25.500	54'-0"	1°-54.58"	8⅛	72.498	6.042	6	53.836
7	15	6'-6"	8'-6"	16'-6"	6½"	8'-10.16"	17.073	8.573	38.073	6.964	16°-54.00"	27.250	60'-6"	1°-47.56"	9"	84.430	7.036	7	60.581
7	15	6'-6"	8'-6"	15'-0"	6½"	8'-10.16"	17.073	8.573	38.073	6.964	16°-43.48"	27.250	60'-6"	1°-58.43"	8⅛	84.430	7.036	7	58.421
7	8	3'-0"	5'-0"	15'-0"	6½"	8'-10.16"	17.073	8.573	38.073	6.964	14°-30.58"	27.250	60'-6"	1°-58.43"	8⅛	84.430	7.036	7	60.558
7	8	3'-0"	5'-0"	13'-0"	5½"	8'-10.16"	17.073	8.573	38.073	6.964	14°-15.25"	27.250	60'-6"	1°-54.58"	8⅛	84.430	7.036	7	59.768
8	10	4'-0"	6'-0"	16'-6"	6½"	7°-09.10"	19.625	9.623	55.364	7.969	11°-16.40"	29.870	67'-0"	1°-47.56"	9"	96.374	8.031	8	67.869
8	15	6'-6"	8'-6"	16'-6"	6½"	7°-09.10"	19.625	9.623	151.625	7.969	12°-18.08"	28.001	67'-0"	1°-47.56"	9"	96.374	8.031	8	66.370
8	15	6'-6"	8'-6"	15'-0"	6½"	7°-09.10"	19.625	9.623	146.625	7.969	12°-08.11"	25.501	63'-6"	1°-58.43"	8⅛	96.374	8.031	8	64.015
8	15	6'-6"	8'-6"	13'-0"	5½"	7°-09.10"	19.625	9.623	146.625	7.969	11°-54.22"	25.501	63'-6"	1°-54.58"	8⅛	96.374	8.031	8	63.361
10	15	6'-6"	8'-6"	16'-6"	6½"	5°-43.29"	24.702	11.702	173.702	9.975	7°-12.12"	29.500	77'-0"	1°-47.56"	9"	120.302	10.025	10	77.250
10	15	6'-6"	8'-6"	15'-0"	6½"	5°-43.29"	24.702	11.702	173.702	9.975	7°-04.19"	27.000	74'-6"	1°-58.43"	8⅛	120.302	10.025	10	74.345
12	18	8'-0"	10'-0"	24'-0"	6½"	4°-46.19"	29.750	13.748	227.750	11.978	5°-14.10"	42.001	99'-0"	1°-14.15"	13"	144.248	12.021	12	99.470
12	18	8'-0"	10'-0"	16'-6"	6½"	4°-46.19"	29.750	13.748	201.750	11.978	4°-49.16"	29.001	66'-0"	1°-47.56"	9"	144.246	12.021	12	66.190
15	20	8'-0"	12'-0"	24'-0"	6½"	3°-49.06"	37.301	17.759	267.301	14.983	3°-06.05"	43.751	115'-0"	1°-14.15"	13"	180.159	15.017	15	115.240
15	20	8'-0"	12'-0"	16'-6"	6½"	3°-49.06"	37.301	17.759	235.301	14.983	2°-41.36"	27.751	99'-0"	1°-47.56"	9"	180.159	15.017	15	99.400
16	20	8'-0"	12'-0"	24'-0"	6½"	3°-34.47"	39.815	19.817	279.815	15.985	2°-39.26"	43.998	120'-0"	1°-14.15"	13"	192.193	16.016	16	120.208
20	27	9'-6"	17'-6"	30'-0"	6½"	2°-51.51"	49.806	23.642	348.806	19.970	1°-41.17"	54.582	149'-6"	0°-59.23"	16½"	240.152	20.013	20	150.464

Ventilating the New York Subway.

Sir: It cannot in the least detract from the merit of your excellent editorials (June 15 and 22) upon the ventilation of the subway to refer to this sentence which appears to betray a little confusion:

> Owing to the failure of the engineers to foresee the heating effect of the electric current no provision was made for changing subway air by mechanical draft. . . .
>
> The heating effect of the electric current is to increase the temperature of the subway at all seasons and at all times. So far as known that temperature is always above the temperature of the outside air, and the difference in temperature thus shown is practically the measure of the present ventilation in the subway. If a still higher temperature could be maintained in the sub-

way there would be less need of mechanical draft than there is at present. The point is that if the engineers did not take into account the heating effect of the electric current they builded better than they knew for winter service and summer as well. Temperature and ventilation should not be regarded as identical. No discomfort is occasioned by passing from a cool office or residence to an open surface or elevated car when the temperature is 75° or 80° or more if one can have the benefit of shelter from the sun and a good fresh air breeze. A large amount of hard labor is performed in the sunlight and elsewhere at much higher temperatures than are given above, and the workers are not only in good health but find the work agreeable.

The wonderful adaptation of lung tissue to the work it performs was not perfected without a corresponding gradual development of a breathing instinct. The strength or weakness of the desire to fill the lungs repeatedly and to the fullest extent when in the subway or at an entrance where the subway air is rising, is a better indicator of the quality of the air in question for health and life-giving purposes than any measure of the temperature can possibly be.

Since earth temperatures as shown by wells and shafts increase at the average rate of perhaps 1° for 60 ft. in depth it would be reasonable to think that heat from any source if steadily applied would affect the temperature of the adjacent earth or rock to a corresponding distance. We naturally think of heat as rising, chiefly because warm air rises on account of its lighter specific gravity, but heat may be said to move from a warm to a cooler object quite without regard to direction.

Surfaces of metal or of hard, glassy like substances that are in close proximity to the earth, whether above, below or as ordinary backing, will take in heat rapidly and it may be confidently expected that the ventilation of the subway will improve for a considerable period at least, as the temperature during another winter and summer will be increased on account of the failure of the earth to continue to absorb heat as rapidly as it did at first.

Any attempts to improve the ventilation in the subway by cooling is not likely to be successful. Any attempt at improvement by the removal of the warm air of the subway by the aid of fans must be in opposition to the natural draft that occurs under the present conditions. The natural draft would first have to be overcome and then the degree of ventilation would depend upon the capacity of the fans and the degree of uniformity in the quality of the air in the induced currents. This uniformity cannot be easily maintained. Calculations are often disappointing and it is hardly possible to make use of all the factors in any general equation.

Reference has been made to the ventilation of mines but usually a mine has considerable depth in comparison to its area and this greatly aids in promoting ventilation. The subway is more like a mine in close proximity to the surface of the earth, or it might be likened to a very large room with a low ceiling in which it would be hard to maintain vertical currents. Yours truly,

H. F. Dunham.

220 Broadway, New York, July 6, 1905.

(While a high temperature in the subway facilitates the rapidity with which the natural air currents move, we can not agree with our correspondent in believing that high temperatures are to be desired for this purpose, and that the engineers "builded better than they knew." The falling off in the subway traffic and the gain in the elevated railway traffic upset our correspondent's theory as to the pleasure of riding in hot air.

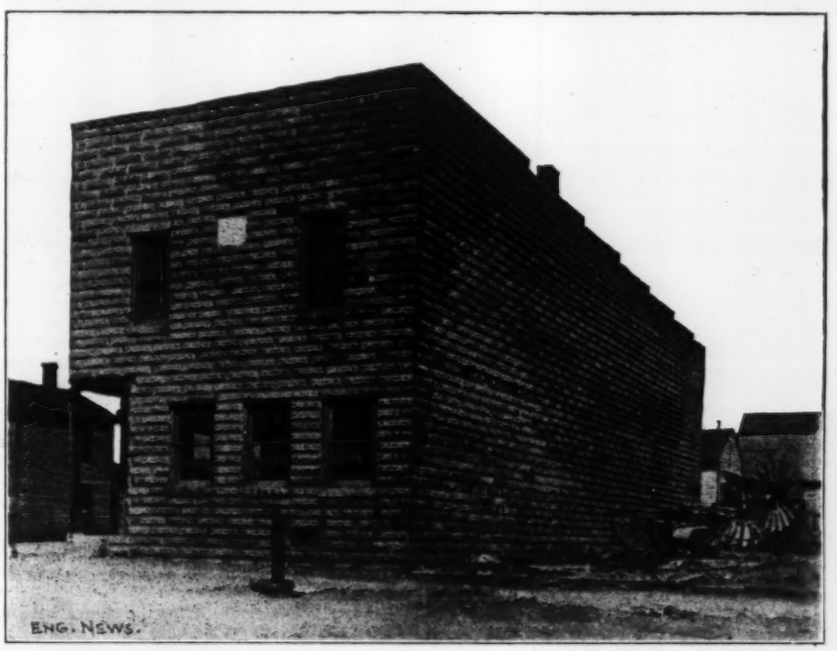
During several cool days recently, when the outside air was 62°, the air in the subway was 80°, because the heated walls of the subway were pouring back some of the heat that they had been accumulating. Great discomfort is felt upon passing from the outside air into the regenerative furnace that the subway is under such circumstances. With the prolongation of the summer season, we may look for worse conditions in the subway, due to the flattening of the temperature curve in the material surrounding the subway, unless the present attempts at mechanical ventilation are greatly improved.

Our correspondent is wrong in assuming that mechanical ventilation can not be made successful because it must be in opposition to natural draft. It is not only possible to aid natural draft, but to dispense with natural draft entirely; and, indeed, if the air is refrigerated before entering the subway (as it probably will be some time in the future) it will be best to prevent the entrance of outside air by natural draft. In shallow mines the very fact that the mine air is cooler in summer than the outside air, makes mechanical ventilation a necessity.

Our correspondent is mistaken also in assuming that the temperature of the earth increases regularly 1° for every 60 ft. in depth, if he refers to temperatures at all times of the year, and for all moderate depths. It is true that when a depth is reached below which the surface changes in temperature have no effect, then there is a steady rise of temperature with increased depth. But the conductivity of soil and rock is so poor that at no great distance from the surface of the earth, the temperature of the ground does not vary much from the mean annual temperature of the air above. Moreover, such variations in the temperature curve as do occur, follow the surface temperature curve some months after the changes in temperature at the surface have occurred, as is demonstrated by the fact that the hottest part of summer comes long after June 22 (the longest day in the year), because the earth's crust absorbs more and more heat the longer it is exposed to the hot summer suns.—Ed.)

Some Comments on the Fireproof and Damp Resisting Qualities of Concrete Block Construction.

Sir: In your issue of May 4, 1905, there is a detail description of the absolute failure of a concrete building erected with "patent stone" made on one of the Patented Mold Boxes now generally boomed to beat brick and stone



CONCRETE BLOCK BUILDING AFTER EXPOSURE FIRE WHICH HEATED ADJACENT WALL BLOCKS RED HOT.

construction. This failure is one of the best of indications that this new industry must receive attention by skilful artisans and those expert with cement and its uses. You will remember that here in New York City we had the Buddensieck method of building with cement, brick, mud and water, but the failure of these buildings, which destroyed life and sent the builder to State's Prison, did not retard the erection of other brick buildings; it did, however, attract the attention of the Building Department to the wilful neglect of inspectors.

Some years ago the patented stone made by the patented mold boxes used in Oklahoma was introduced into this city. Plans were made for a building to be erected in Brooklyn, and these plans were submitted to the Building Department by an architect. They were rejected. This action led the writer to the study of this class of building material and the methods required to manufacture building blocks so that the best results could be obtained. He continued until arrangements were perfected for a product, (1) to be manufactured so that complete inspection could be made of all the material used, (2) to be made in machinery, every detail to be duplicated, and every block to be exactly the same. The new plans were accepted by the Building Department and there are now standing in the 29th Ward of Brooklyn over a dozen buildings in part or in whole made on one machine, and these buildings can be examined by the most critical.

In the matter of fireproof buildings, we know of other buildings made with other kinds of blocks than those which were used in Oklahoma, which did stand in a fire test in the city of Carmel, Ind. We present farther on letters on this matter, which explain themselves.

We wish to call attention to the "patented stone" so minutely described in your report from Mr. Charles Dewalde, as "exploding" and "one-half of the block going one way and the other half the other." This action is very easily explained. These blocks were Buddensieck material, i. e., they were shoddy affairs, similar to miles of cement sewer pipe that collapsed because they were made of a 1-8 mixture instead of a 1-3, or a 1-2-4. This shoddy construction of sewer pipe led to its disuse, and the substitution of better material in the form of glazed baked clay pipe. The shoddy blocks exploded because the material was too porous. These pores absorbed water, and at the time of the fire the blocks contained water that became steam, and the faulty laying of the block, as dead air space, without proper means of ventilation, confined this steam, perhaps superheated steam, with the result cited.

In the laying of hollow concrete building blocks ordinary common sense must be used. It is well known that the atmosphere we live in, on the surface of the earth, stands normally at a pressure of 15 lbs. per sq. in.—one atmosphere; nevertheless this pressure is continually changing, day and night, week in and week out, as we notice on the barometer. When air is dry it sucks out all the water in the various objects around, from man and beast and buildings, and when the water falls in the form of rain it again goes back into everything it comes in contact with. If a block house is full of water, some of it goes out; if the atmosphere is surcharged with water, or it rains, some of it goes into stone, brick, wood, or any form of building material. The more shoddy the hollow block of cement the more water goes in. A stone building or one of brick, or one even of wood, that is not furred to allow circulation of the air, is not sanitary.

There is considerable more to this question, but this homely explanation is enough to show that ordinary knowledge and judgment must be exercised in erecting buildings with hollow concrete building blocks as well as with stone, brick or wood.

The following is a copy of a letter from Charles P. Myers, of Carmel, Ind.:

Sir: I am sending two pictures by express; I had two views made, one before the fire and one after. You can see that the rock face scaled off some. Now this wall at the bottom was nearly red hot. We are pleased with the building, all except one thing. The upper floor when it rains dampens through. Now what can be done to stop the water from soaking through? An ordinary rain will not do this, but a hard driving rain will. The water even ran down the wall on the inside. We have asked several and as yet none have been able to give us a practical answer. If you know anything it will be greatly appreciated.

As this letter is similar to thousands that are going

the rounds of press, and as it is so frankly worded and to the point, we give herewith our answer to Mr. Myers:

Your favor of 5-4-05 received, with photographs of the building "Odd Fellows' Hall and Bank Building" erected with hollow building block made on the machine and press you obtained from us last year.

The dampness in this building came from defective laying of the hollow block. You laid what is called "dead-air-space," i. e., the perpendicular hollow cavities were not ventilated horizontally or crosswise. It is important to insert in the walls at least two registers similar to

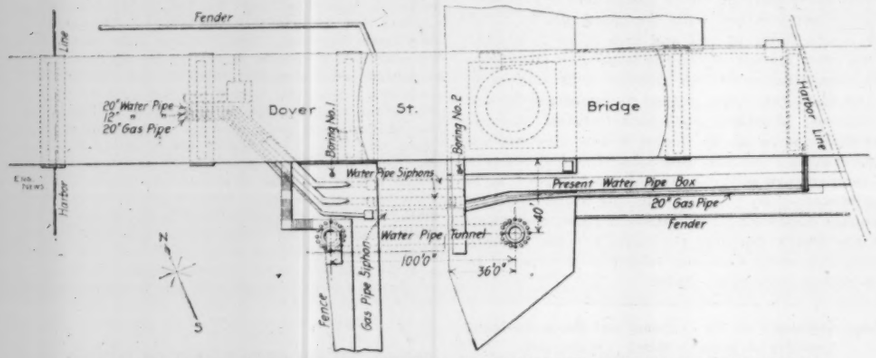


FIG. 1. PLAN OF WATER PIPE TUNNEL AT DOVER ST. BRIDGE, BOSTON, MASS.

hot air registers used in hot air heaters, at least one on each side of the building. This is done easily when the blocks are being made, by inserting the blank register in the bottom of the press. Use these blocks on the floor level of the basement and in the garret. This allows a circulation of air. In laying the blocks, do not put mortar within one inch of the outside of each block to permit of tight joints to be made after the building is constructed with putty mortar or with mortar made of cement and fine stone dust; all to be pointed up after the building is at least thirty days old. If more than thirty days old, it would be better, so that all settlement may have taken place. At least, no building should be pointed until after the frost has all gone. When laying blocks, the laying mortar should not be put on the block between the cavities, so that air can circulate horizontally between the cavities in the block after the block is laid; if this space be but an eighth of an inch it is sufficient. This is very important, and in case you desire to give plenty of cross air, when the block has been struck off and before opening of the press, take a half round piece of molding and make an indentation in the top of the block in the cement between the cores; in other words, in the cement which forms the cross bond walls in each block. When this block is laid in the wall, this cross cut between the holes is open, and even though the laying mortar slopher into it and sets in it, it overcomes the transverse strain, which is the weak point in all forms of concrete block construction.

Now, if you have laid up a building and cannot remake your block, and you find them so porous they take water like a sponge, and explode during a fire, you had better "scratch your head" and try and remedy the defective laying of blocks. We have visited hundreds of buildings made with hollow concrete blocks; we have seen more than a dozen put up from the foundation, and in one case recently we have witnessed a porous block cured. This was done in the following manner: Take a barrel of soft rain water and dissolve at least 25 lbs. of alum; take a similar size barrel and rain water and put into it 3 or 4 palls of soft soap; let the barrels be well stirred, and each stand separately for several days. With the alum water, give the outside of the building from the top down a wash coat, as though whitewashing it; it will soak in very fast, that is exactly what is wanted. Do one side entirely from top to bottom, then begin at the top with the soft soap water in the same manner, that will soak in, too, and that is exactly what is wanted. Let all this be done in dry weather. If rain comes on during the alum washing, you had better go in out of the rain, and begin over again before the soap is put on. Let the building stand several days, you can wash it all down again, if you want to, with water, or the rain may come, but it will never get into the holes that the alum and soap got into, because they have crystallized and have filled up the voids. If after a heavy rain, you consider that the remedy has not accomplished what you set out to do, water and soap and alum are cheap, do it again.

We have also found out that cement blocks after their manufacture can be made more impervious to water by a treatment in the yard, and before the blocks are laid in the wall, by washing them in the same manner, i. e., a wash coat of alum water followed with soft soap wash. In this case gravity aids the treatment and it goes deeper into the block. In technical descriptions this is known as the "Sylvester process," and has been known to make large reservoirs water tight which were laid in concrete when all other methods failed.

A building erected in Philadelphia is shown in a certain catalogue, in which the blocks were made impervious in the machine by the alum process in one-half of the material and the soapy water in the other half of the material, and the two remixed suddenly and tamped in the press. The only trouble with this method is, it takes the blocks too long to cure; it keeps the very water out, the cement is thirsty to get a drink with; and at the same time, the block will not have the strength that the same material would have if made in the ordinary way. Density of cement blocks is a variable quantity according to mix and methods. Some are tamped more, some less, therefore each block has this variable condition. For instance, take a cured block, weigh it, and then insert it in a barrel of water, after laying in water an hour or so, take it out and weigh it, and no two blocks have the same weight. When you put the block in water the air bubbles come forth and the block will seem to be boiling, i. e., the water drives the air out, the air that was in the voids, and the bigger the bubbles the larger the voids in the block, showing defective tamping, and this is true of all poured methods as against tamping methods. It is also true of stone, of bricks, and by the way, a sand lime brick will boil a long time; therefore it is easy to understand what alum and soap do; they fill the voids by the chemical affinity of alum and soap.

Now, another point in your letter: you say the water runs down from the top. Now, allow us to ask you, is the roof below the top of the block, or the walls of your building? If so, did you omit flashing? If the roof is below the block, it will be necessary to flash it by tin or galvanized iron, as in all forms of building, whether of stone, or brick, or wood. After flashing, give the entire inside wall above the roof a coat of astralite, which we read is a water-proofing material manufactured in Indianapolis, or send for a barrel of "roofleak," or get a barrel of tar and do it yourself.

If you use blocks in the construction of this building below the ground you have got to dig all around the outside of the building and tar the foundation blocks on the outside from the bottom block up to the surface. Anyone who told you to use hollow building block as the foundation for your house without filling up the holes in the blocks with rich concrete and without treating that side of the block to natural earth was a "damp phool." Lastly, put a heater in your cellar, open a few of the air spaces, top and bottom, and live in comfort.

Yours truly, Noyes F. Palmer.

180 Snediker Ave., Brooklyn, N. Y., June 20, 1905.

PIPE TUNNEL AT DOVER ST. BRIDGE, BOSTON.

By Frederic I. Winslow.*

The ease with which work has been performed of late years under compressed air has led to the substitution of tunnels in place of the old style heavy pipe siphons, where the pipe, being imbedded in concrete and once sunk in place, is inaccessible for repairs.

One of the Boston siphons was wrecked a few winters ago, and several narrow escapes from similar accidents have been observed, and in view of the fact that it was proposed to widen the channel at Dover Street bridge, thus throwing out of commission the two siphons there, carrying a 12-in. and a 20-in. pipe, it was decided to construct a brick-lined tunnel, 8 ft. internal diameter and 100 ft. between centers of the shafts, Figs. 1 and 2.

Circular fenders, Fig. 3, were constructed around the sites for the shafts, and work was commenced Jan. 1 of this year, the fenders being finished Feb. 19.

The cylinders or shells for the shafts were constructed in two lengths, of 20 and 12 ft. respectively, the longer length being sunk first, and the shorter one bolted to it. These cylinders were 10 ft. in diameter, and ⅝-in. in thickness.

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The elevation of the bottom of the lower cylinder was 83.0 above datum. The cylinders were lined with 16 ins. of brick before being lowered, excepting a small section near the top, which was lined just previous to letting on the air.

The air-lock, which was 6 ft. in height and the same in diameter, proved to be a very convenient chamber in which to "take air" The lock was bolted to a diaphragm which was bolted to the top of the upper cylinder. This left a circular ring which was utilized for the insertion of bolts for the transference of the lines for the tunnel from above. Air was put on on Feb. 23, and excavation promptly begun.

A depth of 6 ft. below the bottom of the cylinder was excavated and lined with brick, and the process was repeated until the grade of the invert was reached.

No borings were taken at the exact site of the tunnel, but at points about 40 ft. away. The material excavated began with silt, followed by yellow clay, and then a fairly stiff blue clay.

Throughout the work the men worked in shifts of 11 hours each, and after the horizontal portion was fairly begun, a speed of 5 ft. per day of finished tunnel was made. The lining was but 1 ft. in thickness in the horizontal section, although in general the limits of excavation as shown on the drawing was exceeded; this extra space being filled with masonry.

But one cave-in occurred, when a portion of the roof 10 ft. in length and for 5 ft. above the roof level came in, but without injury. A length of 10 ft. was taken out at a time, the roof being

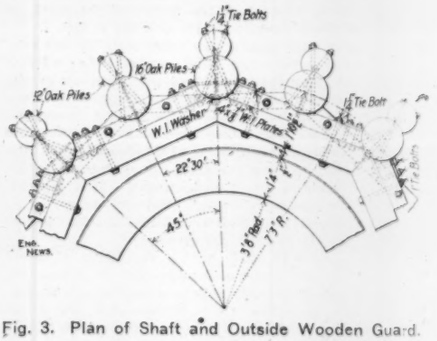

Fig. 3. Plan of Shaft and Outside Wooden Guard.

held by thin plates supported by posts, removed as the work of laying brick progressed. No shield was used.

The material in general was a fairly stiff blue clay with sand seams. To reduce the permanent leakage to a minimum, a specially fine sand was used, resulting in a leakage at the present time of 200 gallons in 24 hours, although on a warm day this has been as low as 24 gallons. The joints were calked, after they had set, with an ordinary calking tool, and the entire surface of the tunnel was plastered. No waterproofing material was used.

The distance between the top of the tunnel and the bottom of the channel is 17 ft.

The air pressure maintained varied from 18 to 24 lbs.; but one compressor being in service, ex-

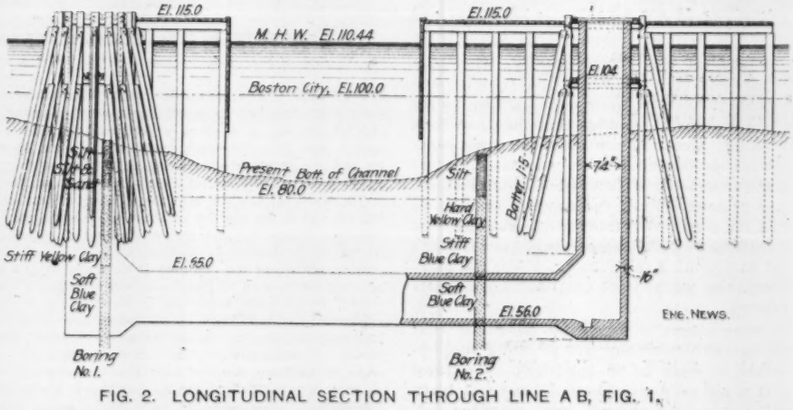

FIG. 2. LONGITUDINAL SECTION THROUGH LINE A B, FIG. 1.

cepting for a short time toward the end of the work.

An interesting feature of this work was the demonstration of the ease and practicability of "taking the air" rapidly, one minute being all that was usually taken, unless the workmen were suffering from a cold. This tunnel is intended to carry a 16-in. and a 24-in. water-pipe.

The contractor was Mr. Chas. A. Haskin, and the work was done under the supervision of Mr. William Jackson, City Engineer; the Engineer in Charge, being Mr. F. A. McInnes.

A NEW CARBON FILAMENT FOR INCANDESCENT LAMPS.*

By John W. Howell,† M. Am. Inst. E. E.

I have the pleasure of presenting to you some data on a new carbon filament, which has characteristics so differing from those of any previously known filament as to seem to indicate that it is a new form of carbon. Beside being very interesting on account of its physical characteristics, this filament is of considerable value on account of its much better life or efficiency than the carbon filaments heretofore known. This new filament is the result of work done in the Research Laboratory of the General Electric Co., and in the laboratory of the Lamp Works, at Harrison, N. J.

In briefest outline, the new characteristics of the filament may be said to be due to the proper application of excessively high temperatures to the ordinary carbon filament. The value of the product is determined by the conditions under which the high temperatures are applied.

It is well known that an ordinary incandescent filament in an evacuated lamp may be heated to excessive temperatures by the application of high current without producing any beneficial change in the filament. To produce the effects described in this paper the heat is externally applied to treated filaments at atmospheric pressures. The simple application of the highest attainable temperatures to the plain carbonized cellulose fiber, i. e., the so-called "filament base," is also incapable of producing any considerable change in the filament. This high temperature treatment of the base is, however, a beneficial step in the process here described.

Before describing the new process, it may be well to recall the steps by which the standard filaments are made. A solution of cellulose is squirted through a die into a liquid that hardens the cellulose. The resulting fiber is dried, then shaped into the desired form

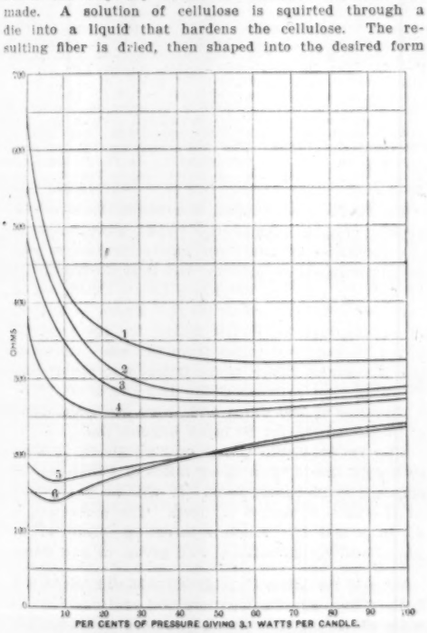

Fig. 2. Resistance-Temperature Curves Giving Resistance in Ohms.

FIGS. 2 AND 3. EFFECT OF FIRING TREATED LAMP FILAMENTS AT DIFFERENT TEMPERATURES.

Curve 1: Ordinary un-fired treated filament.
Curve 6: Treated Filament fired at highest temperature.

for the finished filament and heated in a muffle until carbonized. In this process the highest temperature of a gas-furnace is employed. The product at this point is called a "base filament." The base filaments are usually separately heated by a current ed through them while they are surrounded by an a sphere of hydrocarbon vapor, and in this way a coat shell of graphite is deposit upon them. They are en said to be treated f ments. The best quality standard carbon incandes lamps of to-day owe the uperiority to the use of t ted filaments.

In att ting to graphitize carbon filaments it was discover that treated filaments undergo very remarkable changes when subjected to the highest possible temperature of an electric resistance furnace. The furnace consisted of a carbon tube, held at the ends by large water-cooled copper clamps; the tube was imbedded in powdered carbon to prevent its combustion. The filaments were packed in small, cylindrical carbon boxes, which were fed into the heated tube. The temperature was usually between 3,000 and 3,700° C. Under such firing the ordinary treated filament changes in appearance; its graphite coating looks as though it had been melted, and its specific resistance is greatly reduced. The resistance of one of these filaments, measured at ordinary temperature, may be reduced as much as 80% by the firing.

The curves representing the resistance at different temperatures are also remarkable. Fig. 1 shows curves of resistance and temperature of a regular base filament,

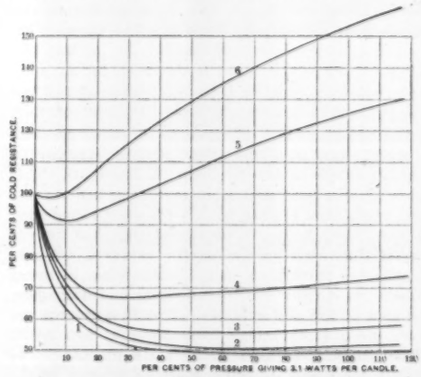

Fig. 3. Resistance-Temperature Curves Giving Resistance in per cent. of Cold Resistance.

a base filament fired, a regular treated filament, a treated filament fired, a shell of regular treated filament, and a fired shell.

The resistance in ohms is plotted against the temperature, as indicated by the percentage relation of the pressure on the filament to the normal pressure at which the filament has an efficiency of 3.1 watts per candle.

The curves show a more rapid fall in resistance of

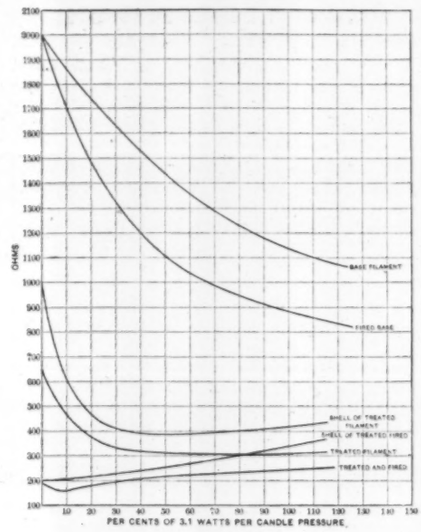

Fig. 1. Curves of Resistance at Various Temperatures of Carbon Filaments with Different Treatments.

Temperature is expressed in per cent. of normal pressure on a standard incandescent lamp.

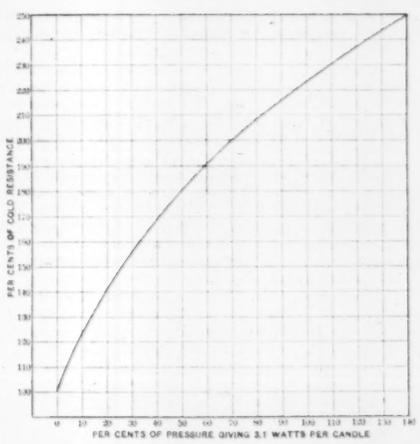

Fig. 4. Resistance-Temperature Curve of Fired Filament, Having Thick Treatment on Thin Base.

the base filament after firing, but little change in the character of the curve.

The change produced in the treated shell by firing is very great, the cold resistance being reduced from 1,000 to 200 ohms, while the great change in the character of the curve of the fired shell brings the hot resistance of the two shells nearly together.

The resistance curve of a fired treated filament depends upon the relative thicknesses of base and coating and upon the temperature of firing. Figs. 2 and 3 show curves of filaments fired at five different temperatures and of a similar filament that has not been fired. In Fig. 3 the resistances are shown in percentages of the cold resistances, and in Fig. 2 the actual resistances are shown.

These filaments were heated in the carbon-tube resistance furnace. They were enclosed in a cylindrical carbon box, placed inside the tube, one end of which was left open for observation. An indication of the temperature was obtained by looking directly into the open end of the tube at the box holding the filaments, and holding in the line of vision the filament of an ordinary 50-volt lamp, the temperature of which was adjusted until the filament became invisible against the incandescent carbon box. The pressure on the lamp was then observed and the box of filaments taken out.

Curve No. 1 is the resistance curve of a regular treated filament.

Curve No. 2 is the curve of a similar filament heated in the tube to a temperature corresponding to the temperature of a carbon filament operating at 153% of its normal pressure, or at 125 candles for a normally 16-candle-power lamp.

Curve No. 3 is the curve of a filament fired at a temperature corresponding to the temperature of a lamp at 161% of its normal pressure, or at 163 candles.

Curve No. 4, 183% of normal pressure, or at 230 candles.

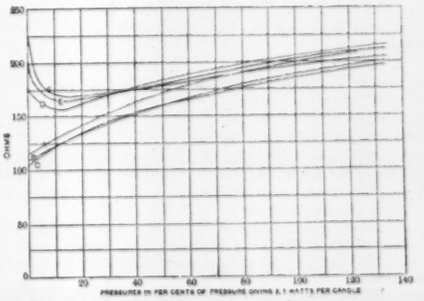

Fig. 5. Effect of Firing Before Treatment.

All curves are for treated filaments fired at same temperature after treatment, but fired at different temperatures before treatment. Curve A is for filament not fired before treatment. Curve E is for filament fired at highest temperature before treatment.

Curve No. 5, 200% of normal pressure, or at 280 candles, for a 16-candle-power lamp.

Curve No. 6 is the curve of a filament heated hotter than No 5. The temperature was not measured by this method for fear of breaking the comparison lamp.

An attempt was made to measure the temperatures by means of an optical pyrometer (Wanner) which indicated temperatures up to 3,700° C. at the highest heats.

Fig. 4 shows the resistance curve of a filament made

*A paper presented before the American Institute of Electrical Engineers at Asheville, N. C., June, 1905.

†Engineer, Lamp Works, General Electric Co., Harrison, N. J.

from a thin base having quite a thick treatment, this shows a resistance increasing to 250% of its cold resistance.

The change in the resistance curve of this coating from negative to positive seems to be due, in part at least, to the action upon the shell of some substance driven out of the base filament by the high temperature. This is indicated by the considerable change in the curve of a treated fired filament produced by heating the base filament to the same high temperature before it was treated and then reheated. Fig. 5 shows resistance curves of carbons fired at the same temperature after treating, but with the base fired at different temperatures before treating. The base filament in Curve A was unfired; in B, C, D and E the base was fired at successively higher temperatures. It will be observed that the curves made from filaments the bases of which have been heated to high temperatures before being treated are much less positive than the others. The conclusion that the effect produced by material being driven out of the base seems to be borne out by the fact that during the preliminary heating of the base at high temperatures it loses practically all of its mineral ash constituents, and also by the fact that, if some of the elements that the base loses in its high heating be separately placed in the furnace with the treated filaments, effects are produced similar to those observed when the base has not been previously heated. The effect of some agency beside heat is also indicated by the fact that the lamp filament used in the temperature observations, although maintained at the same temperature as the filaments in the furnace, and for a sufficiently long time, showed no indications of such a change as was produced in the filaments in the furnace.

The appearance of a filament fired both before and after treating is very different from that of one fired after treating only. The former has a slightly pebbled appearance, as seen through a microscope, and a rather dull-gray color. The single-fired treated filament is generally very much blistered, many blisters extending outward a distance greater than the diameter of the filament. These blisters indicate an outflow of gas from the base when the shell was in a soft condition. The surface of the filaments is highly lustrous.

The specific-resistance of the highly heated coating has been found to be as low as 0.00006 ohms per cubic centimeter, which is very much lower than the specific resistance of any other known form of carbon or graphite. Its specific gravity is also much higher than it was before heating. Its changed nature is also indicated by its toughness and flexibility. The coating of a double-fired filament may be pulled off in short tubular sections, which if pressed flat, will spring back to their original form when the pressure is removed. The same coating before being fired is comparatively brittle, and will break with very little pressure. On account of the positive resistance curve and physical characteristics of these filaments, they have been given the name "metallized filaments."

The treated coating on filaments, even before firing, is graphite, as determined by the chemical test established by Berthelot—the production of graphite acid (a yellow insoluble substance) when treated with a mixture of anhydrous nitric acid and potassium chlorate. Ordinary carbon is dissolved by these reagents. The coating on the treated filament has also the greasy feel of graphite, and gives the characteristic mark of graphite on white paper. After being heated to high temperatures in the electric resistance furnace these characteristics continue and the chemical action is much more marked.

Metallized filaments blacken the lamp-bulb very much less than ordinary filaments. This may be due to the removal from the former of practically all the mineral ash and other impurities, or it may be due to the changed character of the carbon itself.

Bamboo, coated by dipping in a solution of asphalt, is altered by firing, the coating changing to graphite and giving the characteristic positive curve. Silk dipped in a sugar solution also gives the same result.

The base of a metallized filament, from which the treated coating has been removed, when mounted in a lamp has been found to give the resistance curve of a fired base. Pieces of the coating, about 1.5 in. long, mounted in lamps, have been found to give the strongly positive resistance curve that is characteristic of the metallized filament. These observations show that the change is practically all in the treated coating and not in the base.

Metallized filaments, as above described, are much more stable at high temperatures than ordinary carbon filaments.

The most effective carbon filament lamp now in general use operates at 3.1 watts per candle and under accurate test conditions gives a useful life (to 80% of its initial candle power) of about 500 hours. At the present time metallized filaments that give the same useful life at about 2.5 watts per candle are being produced with a fair degree of uniformity.

PACIFIC COAST ENGINEERING CONGRESS.

Reported by A. H. Fuller,* Assoc. Am. Soc. C. E.

A very successful gathering of Pacific Coast Engineers was held at the Lewis and Clark Exposition grounds, Portland, Ore., June 29 to July 3, 1905, under the name of the Pacific Coast Engineering Congress.

The following organizations participated in the Congress, which was also the Annual Convention of the first three: Pacific Northwest Society of Engineers; Technical Society of the Pacific Coast; Pacific Coast Electric Transmission Association; Officers of the Corps of Engineers, U. S. A.; Engineers of the U. S. Reclamation Service; Montana Society of Engineers; Washington State Chapter, American Institute of Electrical Engineers.

The organization was perfected at the opening meeting by the election of Mr. George W. Dickie, President of the Technical Society of the Pacific Coast, as presiding officer, and Mr. Milnor Roberts, Secretary of the Pacific Northwest Society of Engineers, as Secretary. General meetings were held on Thursday morning and Friday afternoon. The Congress met in two sections on Thursday afternoon and Friday morning. Saturday and Monday were given to excursions. The total enrollment was 206, including ladies, and the average attendance about 75. Twenty-six papers were presented. Owing to the large number of papers in proportion to the available number of sessions the discussions, with few exceptions, were necessarily limited.

GENERAL SESSIONS.

After the organization of the Congress was effected and addresses of welcome were made by President H. W. Goode, of the Exposition, C. E. Fowler, Past President of the Pacific Northwest Society of Engineers, George W. Dickie, President Technical Society of the Pacific Coast, and George P. Low, Secretary of the Pacific Coast Electrical Transmission Association, a number of interesting papers were then presented.

THE SYSTEM OF THE PORTLAND GENERAL ELECTRIC CO. By F. G. Sykes, General Superintendent, Portland, Ore.—The present plant is composed of four distinct systems:—A three-phase, 10,000-volt, 33-cycle transmission system; a 60-cycle distributing system at 2,300 volts; two 550-volt, direct current systems, one for street railways and one for arc lights. The power is generated at Oregon City, by turbine wheels under a head of about 40 ft.

THE NEW POWER PLANT OF THE OLYMPIA LIGHT & POWER CO. AT TUMWATER, WASHINGTON. By E. W. Cummings, Consulting Engineer, Seattle.—Although the present installation succeeds a still smaller one of but two 500-KW. units, the plant is designed for an ultimate capacity of 3,000-HP. To realize this a billion cubic foot storage reservoir has been planned.

The old plant was supplied with water through a closed wooden flume 10 ft. square, designed a number of years ago by John R. Freeman. This flume is still used and is extended by a 9-ft. riveted steel pipe ending in a 7-ft. steel stand-pipe at the power house. This stand-pipe has an enlarged top, with provisions for carrying off surplus water through a 42-in. waste pipe, in order to prevent it from ever overflowing and damaging the roof of the power house. The pipe crosses the river on a steel bridge, consisting of one 84-ft. Pratt truss and three 40-ft. plate girders. The wheels are Victor turbines under a head of 86 ft., mounted on horizontal shafts, direct connected to dynamos.

The power house is built of Tenino sandstone, with concrete foundations on solid rock, on an island at the foot of the lower falls.

THE IMPROVEMENT OF THE COLUMBIA RIVER BETWEEN THE DALLES AND CELILO. By Major W. C. Langfitt, Corps of Engineers, U. S. A., and Capt. Amos A. Fries, Corps of Engineers, U. S. A.—The importance of free navigation of the Columbia River and its tributary, the Snake, from Portland and the ocean to the inland portions of Washington, Oregon and Idaho, has long been felt, not only by the inhabitants of the "Inland Empire," but by the U. S. Government as well. Numerous commissions have examined and reported upon the various portions of the work, and many substantial improvements have already been made. Actual construction has now been authorized upon portions of the work which forms the subject of this paper, and bids will be received soon.

A unique feature of the provision for this work is that, according to the conditions of the act of Congress authorizing it, the right of way for the Dalles-Celilo Canal, 13 miles in length, was secured by purchase by the State of Oregon, and deeded to the U. S. Government.

As explanatory of the local conditions, the following extract from the paper is inserted:

> The construction of the canal, and improvement of the Three Mile Rapids, have been undertaken for the purpose of overcoming a complete bar to navigation formed by the falls and rapids in the Columbia River in the 13 miles between The Dalles and Celilo, Oregon. A brief description, however, of the river would seem an essential preliminary to a consideration of any work of such magnitude as the one in question.
>
> The Columbia River is the one large river flowing into the Pacific Ocean within the limits of the United States. It is in fact the largest river on the Pacific Coast, volume of discharge and drainage area both considered. It is the second largest river in the United States and its drainage area covers approximately 245,000 square miles. The low water discharge, 200 miles from its mouth, is approximately 50,000 sec. ft., while the high water discharge is, approximately, 1,500,000 sec. ft., or more. The Cascade Range of mountains extends north and south throughout the states of Washington and Oregon, and California, to San Francisco. The range lies about 100 miles inland and, except where broken through by the Columbia River, forms a continuous barrier between the eastern and western portions of the Northern Pacific States. These mountains, therefore, divide the drainage basin into two portions, of which it has been estimated that 185,000 square miles lie in the eastern portion. The Columbia is now navigable at low water for ships drawing 23 ft., from its mouth to the junction of the Willamette River with it, a distance of 100 miles.
>
> In its natural state, above the Willamette, the Columbia was divided into navigable reaches of greater or less length, these reaches being separated from each other by falls and rapids stopping all navigation at practically all stages. Going up-stream from the Willamette the first reach extends to the Cascades, 55 miles, the river being navigable for boats drawing 7 to 8 ft. of water. The next reach extends from above the Cascades to about two miles above the Dalles. This reach is also navigable for boats of 7 to 8 ft. draft at all stages from low water to 38 ft. above that datum (at the Cascades) and is 45 miles in length. A canal with locks has been constructed around the Cascades, which, while not quite completed, has been in operation since 1896. The fall overcome by the locks varies from 24 ft. at low water to 14 ft. at the 38-ft. stage when navigation becomes impracticable. This stage lasts on an average less than 15 days per year.

To further emphasize the importance of the present improvements the paper gave in detail the condition of the river above Celilo. It may be summarized as follows: the first obstruction is at Priest's Rapids, 190 miles above Celilo, where there is a fall of about 90 ft. There is but one other obstruction, Kettle Falls, for the next 500 miles, or over 900 miles from the sea. Considering the Snake River, there is but one obstruction to navigation between Celilo and Lewiston, Idaho, a distance of 260 miles and there are possibilities of improvement for 80 miles beyond that.

The Dalles-Celilo Canal will be about 13 miles in length, more than three miles of which will be through solid basalt rock. It will be 65 ft. wide at the bottom, and 8 ft. deep. The locks will be 45 ft. × 300 ft. Much interesting detail of the plans and specifications was given in the paper.

WORK OF THE U. S. RECLAMATION SERVICE.—Three excellent papers and an informal talk were given on this timely western subject. Mr. D. C. Henny, Supervising Engineer for Oregon and Washington, outlined the organization of the Reclamation Service and its work to date. (See a somewhat similar outline by Mr. F. H. Newell, Chief Engineer U. S. Reclamation Service, Eng. News, June 15, 1905.—Ed.) Mr. John I. Whistler and Mr. T. A. Noble, District Engineers for Oregon and Washington, each presented papers on the work of the service in their respective States. A large part of Mr. Henny's paper will be printed in a later issue.

Mr. E. T. Perkins, Engineer in Charge of the U. S. Reclamation exhibit, on the Exposition

*Dean of the College of Engineering and Professor of Civil Engineering, University of Washington, Seattle, Wash.

grounds, spoke informally of the exhibit and invited the members of the Congress to visit it. By vote of the Congress a visit was made from 5 to 6 o'clock on Friday afternoon. The relief maps, models, plans, specifications and photographs were of great interest and very effective in illustrating all of the irrigation papers.

GENERAL ENGINEERING SECTIONS.

PROBLEMS WHICH CONFRONT ENGINEERING AND KINDRED INDUSTRIES ON THE PACIFIC COAST. By George W. Dickie, President of the Union Iron Works, San Francisco.—The subject was introduced by stating that 30 years ago, on account of limited transportation facilities, the greater part of the machinery used on the Coast was manufactured there, but that in later years eastern competition, through manufacturers' agents, aided by improved transportation facilities, has been keenly felt, and now the western plants must prepare more fully to meet this competition.

In order to offset the fact that wages are higher on the Coast, it behooves the western concerns to study the conditions and make labor more efficient.

The speaker suggested a plan for doing this without introducing piece work, involving cooperation between manufacturer and laborers through committees of the latter, in making estimates for the work and placing in a fund, to be divided among the laborers, once a year, the excess between the estimated and actual cost of the labor item.

Mr. John Richards, of San Francisco, in the discussion, stated that he had personally known of arrangements of this kind to be satisfactory to all parties concerned in various parts of Europe for many years.

THE PRINCIPLES GOVERNING THE VALUATION OF WATER-WORKS UNDER PRIVATE OWNERSHIP. By Arthur L. Adams, Hydraulic Engineer, San Francisco.—This paper of about 6,000 words gave evidence of careful study of the subject and was presented in a forcible manner, as would be expected from Mr. Adams. On account of its nature it is a difficult paper to abstract, but is well worth a careful reading by those interested.

SUBTERRANEAN WATER AS FOUND IN THE VALLEYS OF CALIFORNIA. By John Richards, San Francisco.—This was a short paper in which the author said at the outset that it had been prepared not because he had had extended experience in that line, but because limited experience and extended observation had convinced him that the utilization of underground water for both water supply and irrigation should command much greater attention than at present, and that the few instances he cited were chiefly for the purpose of stimulating interest in that direction. He mentioned one instance where for 14 years there was secured an almost continuous supply of 750 gallons per minute from a well 90 ft. deep operated by a two-stage centrifugal pump.

ENGINEERING PROGRESS IN THE NORTHWEST.—By Charles Evan Fowler, President and Chief Engineer of the International Contract Co., Seattle.—This was a very thorough resume of the engineering achievement in the Northwest, which may be summed up as follows:

Throughout the Northwest, including Alaska, railroad work has been and is very active, and the present tendency is for better roadbeds, including steel bridges to replace the wooden structures so largely used in the past, straightening the lines by the use of tunnels, and other means, and for carefully planned terminals. Water supply has received much attention, with the result that nearly all the cities have splendid supplies. The close proximity of the mountains makes this possible in most localities.

Sewerage had received comparatively little attention, as regards provision for the future. There is need for more work in this field. Irrigation is now being investigated in a systematic manner by the U. S. Government, and a few important projects are under construction. While a great many acres have previously been irrigated, the projects have, as a rule, been small and devoid of conspicuous engineering features. Hydro-electric power plants are necessarily receiving deserved attention. Present demand for power, the probable great increase in that demand, and the existence of splendid water powers have already brought out several notable plants. A great deal is being done in river and harbor improvement, largely, though not entirely, by any means, by the Government.

The iron and steel industries have been but slightly developed. The evidence of ore in paying quantity and quality, successful blast furnace operation, and the recent completion of a small rolling mill, indicate the dawn of great development.

TIMBER TESTS: METHODS AND RESULTS. By Loren E. Hunt, Government Engineer in charge of Timber Testing for the Pacific Coast, Berkeley, Cal.—Mr. Hunt introduced the subject by referring to the first systematic effort to test the mechanical properties of timber, by the late J. B. Johnson, at Washington University, St. Louis, in 1891, and continued by giving in detail the present methods in use by the Bureau of Forestry. He presented data showing comparative results from large timbers of all grades to small selected specimens, and from red (Douglas) fir to western hemlock. The large timbers were found to develop moduli of rupture of from 50% to 90% of those shown by the small specimens, depending upon the dimensions and conditions of specimens. Western hemlock was found to develop somewhat over 80% as much strength and elasticity as the red fir. In the discussion, results were given of some recent tests of Alaska spruce, made at the University of Washington, Seattle, in which the results, from 7 × 8-in. specimens, cut from small trees and full of knots, were less, though not to any great extent, than those obtained from western hemlock and the poorer qualities of fir.

(Concluded next week.)

THE SUBSIDENCE OF STREETS in Chicago is causing some trouble with cable railways and some anxiety as to the foundations of buildings. The blame has been popularly laid to the deep telephone tunnels, which are 30 to 40 ft. below the surface, but from the method of construction it is not thought that voids could have been left to cause such settlement, while the tunnels have been completed for some years at the points of recent trouble. The disturbance of the clay bed by the numerous recent deep foundations for large buildings, and the drainage of water from the clay by these operations, are said to be more probable causes of trouble. At State and Jackson Sts. there was last week a long sag with a maximum depression of 10 ins., and settlements have also been noted near a number of large new buildings. A special commission has been appointed to ascertain the cause and provide a remedy. The Commissioner of Public Works has appointed three engineers to investigate and report upon this matter and also upon the general character of the tunnel construction work. These engineers are Mr. E. C. Shankland, M. Am. Soc. C. E.; Mr. John M. Ewen, M. Am. Soc. C. E., and Mr. Louis E. Ritter, M. W. S. E.

A 52-TON ELECTRIC LOCOMOTIVE has recently been completed in the shops of the Pacific Electric Ry. Co., at Los Angeles, Cal. The machine has four driving axles with a 200-HP. Westinghouse street railway motor connected to each. In order to obtain the weight on the drivers needed to give the required tractive force, the frame was made of 10-in. I-beams, and upon these was placed a layer of steel rails, and the whole was filled in with concrete. The machine is designed for hauling freight cars to San Pedro, where the new deep-water harbor is being constructed, and to which place the company is just completing a new double-track standard gage railway. With the exception of the motors, the control apparatus and the air brake fittings, the locomotive was built entire in the Los Angeles shops of the company.

A NEW TYPE OF ELECTRIC AUTOMOBILE which can run either on the track of an electric railway or on ordinary roads has been invented by Mr. Russell Thayer, M. Am. Soc. C. E., Broad and Arch Sts., Philadelphia. The vehicle is equipped with a trolley pole and when running on the track it takes current from the overhead wire like a trolley car, the return current being transmitted to the rail through chains which are dragged along it. When it is desired to run on roads where there are no overhead trolley wires, the vehicle is driven by a separate motor taking current from a storage battery.

THE WIRELESS TELEGRAPH SYSTEM is being tried on the Chicago & Alton Ry., and trains running at 50 miles an hour have received messages at a distance of 30 miles from the sending station.

THE NEW POST-OFFICE building for New York City is to be located on 8th Ave., between 31st and 33d Sts., directly over the depressed yard of the Pennsylvania R. R., and the surface right for the purchase of the site has been purchased of the Pennsylvania R. R. Co. at a cost of $1,700,000. It is expected that the building to be erected will cost about $4,000,000.

NO MORE 16-IN. COAST DEFENSE GUNS are to be built by the United States. This conclusion is the result of the experience of the past two years, showing that while the 16-in. gun is a most powerful weapon and capable of doing effective work, that the new regulation 12-in. rifle can accomplish all that is required of a coast defense weapon. In addition, the 16-in. weapon costs about twice as much as the 12-in.

The plans of the Endicott Board, convened in 1885 to outline plans for coast defense, provided for 44 of these 16-in. guns, which were to be placed in turrets in pairs. One pair in turrets would cost $1,225,000. The department has gone ahead with the other features of those plans, but has constructed only one 16-in. gun, and though it proved most satisfactory on trial, no more of these powerful rifles will be made.

A SMALL GRINDING MACHINE for preparing compression test specimens has recently been placed on the market by the Riehle Bros. Testing Machine Co., of Philadelphia. It is designed for grinding the faces of cubes of 1-in. to 3-in. size, of stone, brick, concrete, asphalt, etc. The grinding is done in the usual manner by feeding sand and water to a revolving table on the surface of which the specimen is held. The table is 2 ft. 6 ins. in diameter and is driven at 40 revs. per minute, giving a speed of about 240 ft. per minute for the rubbing surface.

HOPPER-BOTTOM COAL CARS with middle and end hoppers are being introduced on the Caledonian Railway, Scotland. From the middle hopper the bottom slopes up till it is over the inner axle of each truck, and then down to a little beyond the outer axle, when it again slopes up till it meets the end. The middle hopper has inclined doors 47¼ × 31 ins. each, and the inclined part of each end hopper has a door opening 42 × 24 ins. between the sills. With this arrangement the length may be reduced for a given capacity, and these 30-ton cars are 2 ft. 6 ins. shorter than they would have been if made with the middle hopper only. The cars are 35 ft. long over the sills, 8 ft. 6 ins. wide over all, and 8 ft. 5 ins. high from rail to top; the truck wheelbase is 5 ft. 6 ins., and the trucks are 22 ft. 6 ins. c. to c. The trucks have Fox pressed steel frames, with spiral springs over the boxes. The cars are rated at 30 gross tons capacity, and weigh 31,600 lbs. empty. They were built by the Leeds Forge Co.

LARGE PASSENGER TANK LOCOMOTIVES are being used by the Great Western Ry., of England, for very fast trains on the main line. One of the trips is 120 miles long, with five stops, but as water is taken from track tanks the engine tanks (on each side of the boiler) are not exceptionally large. The engines are of the Atlantic type, with large outside cylinders and very large driving wheels. The connecting rods drive the first driving axle. The dimensions are as follows:

Driving wheels	6 ft. 8½ ins.
Truck wheels	3 ft. 2 ins.
Trailing wheels (radial axle)	3 ft. 8 ins.
Wheelbase, driving	8 ft. 6 ins.
Wheelbase, truck	7 ft. 0 ins.
Wheelbase, total	32 ft. 0 ins.
Truck pin to first driving axle	12 ft. 0 ins.
Length over all	41 ft. 4 ins.
Weight on drivers	35 tons
Weight, total	58 tons
Cylinders	18 × 30 ins.
Steam ports	1¾ × 31½ ins.
Exhaust ports	4¼ × 31½ ins.
Boiler wagon top, diameter	5 ft. 0 ins. and 4 ft. 3 ins.
Working pressure	195 lbs.
Firebox, length	6 ft. 2 ins.
Firebox, width	4 ft. 3 ins.
Firebox, depth	5 ft. and 6 ft. 0 ins.
Tubes, 289; diameter	1⅝ ins.
Tubes, length	11 ft. 4¼ ins.
Heating surface, tubes	1,397 sq. ft.
Heating surface, total	1,518 sq. ft.
Grate area	20½ sq. ft.
Water capacity	2,400 U. S. gallons.
Tractive force	21,190 lbs.

SIX MUNICIPALLY OWNED PASSENGER STEAMboats for use on the River Thames, at London, England, have just been completed for the London County Council by J. I. Thornycroft & Co. The boats are of the paddle wheel type, 134 ft. long over all, molded to a width of 18 ft. and a depth of 7 ft., carry 500 passengers, and are designed to run at 13 miles an hour. These boats make numerous stops along the river, and carry passengers at a low rate of fare. They are the outcome of much public discussion over the like service rendered by private boats and over the advisability of municipal ownership.

THE 18-HOUR CHICAGO-NEW YORK TRAIN of the Pennsylvania R. R. is composed of four cars: composite baggage and smoking car, 110,000 lbs.; dining car, 132,000 lbs.; sleeping car, 120,000 lbs.; compartment sleeper and observation car, 115,000 lbs.; total, 447,000 lbs. The correct distance for this run (as given to us officially) is as follows: New York to Pittsburg, 436.4 miles; Pittsburg to Chicago, 468.4 miles; total, 904.8 miles.

A 14-IN. MACHINE BANDED REDWOOD WATER main under a pressure of 250 ft., or 108 lbs., is being built by the Detroit Copper Mining Co., of Morenci, Ariz. The pipe will be used to convey water to concentrators. It was banded, before shipment, with No. 0 (0.307-in.) galvanized rod, spaced 1¼ ins. c. to c. Just before the banding is wound around the pipe and pressed into the wood by the tension applied on the banding machine, it is dipped in hot asphaltum. The staves of the pipe are cut from 1½ × 4-in., well seasoned, clear redwood. The end joints are made with cast iron collars, driven onto the pipe. This pipe is being supplied by the National Wood Pipe Co., of Los Angeles, Cal. The same company is also supplying 8 to 16-in. pipe to convey water to the concentrators of the Consolidated Copper Co.

PERSONALS.

Mr. Martin Sutz has been appointed City Engineer of Celina, O.

Mr. Fred Stadelman has been appointed Assistant Manager of the New York office of the Wellman-Seaver-Morgan Company, at 42 Broadway.

Dr. Andrew Sledd, on July 7, was elected President of the new State University of Florida. The university will be located at Gainesville, Fla.

Mr. W. S. Ruggles has been appointed Assistant Engineer of the Oklahoma division of the Atchison, Topeka & Santa Fe Ry., at Arkansas City, Kan.

Mr. Raymond Griffin, a Civil Engineer, employed by the New Orleans Terminal Company, at Cairo, Ill., was injured in a railroad wreck recently near New Orleans, La.

Mr. H. T. Douglas, Jr., Chief Engineer of the West Side Belt R. R., at Pittsburg, Pa., has been appointed Consulting Engineer of the Wabash R. R., east of Toledo, O.

Mr. E. S. Ball, Jun. Am. Soc. C. E., has opened an office as Contracting Engineer for reinforced concrete and cement block construction, at No. 1 Madison Avenue, New York City.

Mr. Harry K. Briggs, Civil Engineer, of Athol, Mass., and Miss Maud Vining, of Hingham, were married recently. Mr. Briggs is an Engineer with the Metropolitan Sewer Co., of Boston.

Mr. Charles E. Magoon, Governor of the Canal Zone, has been appointed Minister to Panama. Governor Magoon is a member of the Executive Committee of the Isthmian Canal Commission.

Mr. C. Lee Cook, of Louisville, Ky., and Miss J. Elizabeth Whitney were recently married at Kansas City, Mo. Mr. Cook is a Mechanical Engineer. They will reside at 1052 Third Street, Louisville.

Mr. Frank C. Dillard has received an appointment as Engineering Aid, and has been directed to report for duty to J. T. Whistler, Pendleton, Oregon. He is a graduate from the Civil Engineering course of the University of Oregon.

Mr. A. T. Hardin, Assoc. M. Am. Soc. C. E., Engineer Maintenance-of-Way of the New York Central & Hudson River Ry., has been appointed Assistant to the General Manager, with headquarters at New York.

Mr. G. B. Wilson, who for several years has been Consulting Engineer to the Chinese Engineering & Mining Company, Ltd., of Tientsin, China, has returned to the United States and opened offices at Los Angeles, Cal.

Lieutenant O. J. Whitney has been appointed Superintendent of the Medford, Mass., water-works system, succeeding F. W. Gow, resigned. Mr. Whitney was graduated from the Civil Engineering course at Tufts College, in 1894.

Mr. Herbert Spencer, Jun. Am. Soc. C. E., of Fulton, N. Y., and Miss Fanny Twiner Randolph were married on June 1, at Blythewood Plantation, Bayou Goula, La. Mr. Spencer is engaged on Barge Canal work at Bayou Goula.

Mr. Harry V. Croll, M. E., for the past eight years with the E. P. Allis Company, and its successor, the Allis-Chalmers Co., of Chicago, has resigned and accepted a position with the Wellman-Seaver-Morgan Company at Cleveland, O.

Mr. George W. Vaughan, M. Am. Soc. C. E., Division Engineer at Buffalo, N. Y., of the Western Division of the New York Central & Hudson River R. R., has been appointed to a position on the staff of the Chief Engineer at New York.

Mr. D. L. Sommerville, Division Engineer of the Pennsylvania Division of the New York Central & Hudson River R. R., at Jersey Shore, Pa., has been appointed Division Engineer of the Western Division at Buffalo, succeeding Mr. Vaughan.

Mr. N. B. Porter, lately associated with the South Baltimore Steel Car & Foundry Co. and the Ryan-McDonald Manufacturing Co., has accepted the position of General Sales Manager of the Continental Car & Equipment Co., Whitehall Bldg., New York.

Mr. H. W. Parkhurst, M. Am. Soc. C. E., for several years Bridge Engineer and Consulting Bridge Engineer of the Illinois Central Ry., has opened an office at 1643 Monadnock Block, Chicago, for general bridge engineering, more particularly for reinforced-concrete work.

Mr. C. T. Kinney, formerly Supervisor of Water Softeners for the Chicago & Eastern Illinois R. R. Co., has associated himself with the U. S. Wind Engine & Pump Co., of Batavia, Ill. He will be identified with the railway and water softening department of this company.

Mr. Howard S. Reed, of Utah, Assistant Engineer, has been transferred from the Uinta Indian Reservation, Utah, to hydrographic work under L. C. Hill, at Phoenix, Arizona. Since June, 1902, he has been engaged as Hydrographer and Assistant Engineer on the Uinta Indian Reservation.

Messrs. Ballantyne & Evans, Architects, 22 Pine Street, New York announce the dissolution of their partnership. Mr. Henry F. Ballantyne, Mem. N. Y. A. L., will continue practice as an architect and Mr. Myron Edward Evans, Assoc. M. Am. Soc. C. E., as a civil engineer, at 22 Pine Street, New York.

Mr. C. M. Jones has been appointed Acting Engineer of Roadway on the Atlantic Coast Line R. R., at Wilmington, N. C., vice Mr. George B. Huske, resigned on account of ill health. Mr. Jones was formerly Assistant Engineer of the Baltimore & Ohio R. R., and more recently, Assistant Engineer on the Atlantic Coast Line.

Mr. Paul F. Canfield, of Norfolk, Conn., and Miss May Akeroyd, daughter of Mr. and Mrs. Benjamin S. Akeroyd, of Pittsfield, Mass., were married on June 29, at the home of the bride's parents, 84 West Housatonic Street. Mr. Canfield is a Civil Engineer for the New York, New Haven & Hartford R. R., at New Haven, Conn.

Mr. E. P. Lovell, Adjunct Professor of Civil Engineering at Columbia University, who, on June 22, was stated to have been appointed Dean and Director of the Department of Civil Engineering of Cornell University, requested that the nomination be withdrawn which was done. No further action was taken by the Board of Trustees.

Messrs. Rudolph Hering, M. Am. Soc. C. E., 170 Broadway, New York; Frederick Pike Stearns, M. Am. Soc. C. E., Boston, Mass., and Samuel Merrill Gray, M. Am. Soc. C. E., Providence, R. I., have been appointed Consulting Engineers to the Sewerage Commission of Baltimore, Md., in connection with the construction of the proposed sewer system in that city.

Mr. Ernst Wiener has opened offices at 68 Broad St., New York, under the firm name of the Ernst Wiener Company, and will make a specialty of railroad supplies and railroad materials. Mr. Wiener was for 18 years connected with the firm of Arthur Koppel, at 68 Broad St., for eight of which he was Manager of the New York office. Associated with Mr. Wiener is Mr. Carl Koch, formerly Chief Engineer of the Koppel firm.

Mr. Charles S. McAllister, Chief Engineer, has been appointed Engineer-in-Chief of the Revenue Cutter Service, Navy Department, succeeding Captain John W. Collins, who is now on extended sick leave. Mr. McAllister has been on duty in the Treasury Department for some time, in connection with the designing and construction of machinery for the revenue cutters. He is a graduate of Cornell University.

Mr. Solomon LeFevre Deyo, Chief Engineer of the Interborough Rapid Transit Co., 21 Park Row, New York, has resigned his office to associate himself with the Ryan-McDonald-Metropolitan Ry. Syndicate. He is succeeded by George H. Pegram, M. Am. Soc. C. E., who, since February 1, 1898, has been Chief Engineer of the Manhattan Division of the Interborough Rapid Transit Company. Mr. Deyo is a Vice-President of the American Society of Civil Engineers.

Messrs. E. C. Shankland, Rookery Bldg., Chicago, M. Am. Soc. C. E.; John M. Ewen, 143 Dearborn St., Chicago, M. Am. Soc. C. E., and Louis E. Ritter, M. W. S. E., have been appointed by the Commissioner of Public Works of Chicago, Mr. Patterson, to examine and report upon the construction methods and work of the Illinois Telephone Construction Co.'s tunnel system, especially in relation to the recent settlement of the streets at various places.

Mr. Francis W. Frost, Assistant Treasurer of the Engineering News Publishing Co., sailed on the "Manchuria" of the Pacific Mail S. S. Co., from San Francisco, on July 8, for Japan, the Philippine Islands and China. Mr. Frost will accompany the party of Secretary of War Taft, on the trip to visit various sections of the Philippine Islands. From Manila Mr. Frost will continue around the world visiting China, the Straits Settlements, Ceylon, India, Egypt and several countries in Europe. His address until August 30 will be care of the Far Eastern Review, Manila, P. I.

Obituary.

Edward F. Weaver, a Civil Engineer, of Denver, Colo., killed himself on June 28, at Watson Camp, near Florence, Colo.

Ray Gaul, for many years Chief Engineer of the Union Ferry Company, New York, died recently at Woodstock, N. Y.

William E. Matson, an Electrical Engineer, died in Lynn, Mass., on July 6, of typhoid fever. He was a graduate from the Ohio State University in the class of 1894.

William A. Voorhees, of Greggstown, N. J., died on July 10, at the age of 87 years. He had built more than 100 bridges in New Jersey, principally in Somerset County.

David Lee, Consulting Engineer to the Baltimore & Ohio R. R., died at his home in Zanesville, O., on June 29. Mr. Lee was born in Baltimore, Md., in 1820. Three sons survive him.

Thomas Preston, Superintendent of the International Pump Company's Works, at Erie Basin, Brooklyn, N. Y., died at his home in Brooklyn, on June 28. He was born in England in 1820. Two daughters and one son survive him.

Gilbert Johnson, of Denver, Colo., was stabbed on July 5, at Urique, Chihauhua, Mexico, by a Mexican peon. He died of his wounds. He was Chief Engineer at the mines in Urique controlled by Thomas W. Lawson, of Boston. Mr. Luis N. Rahn, the General Manager, was severely wounded.

William Carter Harris, a Civil Engineer, died on June 29, at his home, 366 Main Street, Gardner, Mass., from tuberculosis. He was 47 years old. Mr. Harris had travelled extensively in the United States and in South and Central American countries as a Constructing and Consulting Engineer.

T. Henry Randall, an Architect, of New York, died on July 7, at Annapolis, Md. He was born in Annapolis on July 5, 1869, and was educated at St. John's College, Johns Hopkins University and the Massachusetts Institute of Technology. He was sometime associated with H. H. Richardson, of Boston, and McKim, Mead & White, New York. Mr. Randall was a member of the Reform and Calumet Clubs.

ENGINEERING SOCIETIES.

COMING MEETINGS.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
July 7 and 8. Semi-annual meeting at Chicago, Ill. Secy., W. M. Mackay, New York, N. Y.

LEAGUE OF AMERICAN MUNICIPALITIES.
August 23 to 25. Annual meeting at Toledo, O. Secy., J. McVicar, Des Moines, Ia.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.
August 23 to 25, 1905. Annual convention at Erie, Pa. Secy., F. P. Foster, Corning, N. Y.

AMERICAN PUBLIC WORKS ASSOCIATION.
August 30, 31, 1905. Annual meeting at Chattanooga, Tenn. Secy., W. H. Flint, Chattanooga, Tenn.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Sept. 5 to 7. Annual meeting at Montreal, Canada. Secy., Geo. W. Tillson, Brooklyn, N. Y.

ROADMASTERS & MAINTENANCE OF WAY ASSOCIATION.
Sept. 12, 14. Annual meeting at Niagara Falls, N. Y. Secy., C. E. Jones, C., B & Q. Ry., Beardstown, Ill.

AMERICAN ELECTROCHEMICAL SOCIETY.
Sept. 18 to 20. Annual meetng at Bethlehem, Pa. Secy., S. S. Sadtler, 39 S. 10th St., Philadelphia, Pa.

ENGINEERING LITERATURE

Supplement to ENGINEERING NEWS. New York, July 13, 1905.

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Our readers are more or less familiar with the confusion of nomenclature which has existed during the past dozen years with reference to the combination of concrete with steel. In translations of articles from foreign publications particularly, the English language has been seriously strained, and we have had "armed cement," "armed concrete," "ferro-concrete" and various other misapplications. The climax appears to be reached, however, in the columns of an esteemed contemporary, which in its issue of May 18 discourses learnedly on the need of "more vigorous safeguarding of the quality of the cement and the *entrained* steel!"

The most durable material for book-binding is discussed in the report of the Librarian of Congress for 1903.

He has found that duck of suitable quality is more durable than most leathers of modern tannage and this cloth is now generally used. This material also seems to provide the best insurance known against the injury resulting from rebinding. Good duck bindings are almost indestructible. Another means of reducing the expense of binding in the Library of Congress is the adoption of approved rules for simplifying and abbreviating the lettering on the backs of books. Where a better lettering surface than cloth is desirable in a binding, the cheap and serviceable cowhide offers a substitute.

The Author's Part in the Technic of Book-Making.

The rapid multiplication of technical books and the number of new and therefore inexperienced writers constantly seeking recognition, suggest the desirability of a statement of some of the elementary principles that should guide authors in the preparation of material for the publishers.

The combination of a hastily-written text, carelessly thrown together, and a bundle of crude drawings does not complete the initial stages of a book, from the publisher's point of view. Before the book is presented to the printer someone must supply a title page and a table of contents or chapter heads, a copyright entry, a preface or introduction, and a list of illustrations, if the latter are sufficiently important to warrant it. And last but by no means least, after the book is in type and made up into pages a full and intelligently-made index must be provided.

It pays to go to the expense of having the text typewritten—on one side of the page only, of course. In this form the writer is better able to revise and perfect his manuscript, including its arrangement into sentences, chapters and parts; to indicate plainly the number and position of illustrations; and generally to present his material in such form as will reduce mistakes in typesetting and save time and expense in revising and correcting proofs. And lastly, when the manuscript of a book is submitted to a publisher in a readable and intelligently-assembled manner, it is much better examined by the professional manuscript readers, and an opinion as to its merits and the advisability of its publication is sooner forthcoming. Carelessly-prepared manuscript, though good in material, often repels by its very appearance.

If illustrations are required it is advisable, wherever possible, for the author to have the originals for these illustrations fully prepared for the engraver. To do this properly requires some knowledge of drawing and of preparation of photographs for photo-engraving. The probable approximate size of the page must first be considered; and the drawings should be made with due regard to this size. All drawings are improved by some reduction, as the lines appear finer and more pleasing to the eye; provided that the original drawing is made on smooth paper and in clean, sharp lines in very black ink. For ordinary purposes a "one-half" reduction* of the original is safe for the beginner; this means an original drawing twice as long or wide and twice as high as the proposed illustration. But by paying proper attention to the character of the lines, and especially to the size and form of the lettering and of the figured dimensions, reductions much greater than this can be readily made. Whatever is done, it should be seen that the letters and dimensions do not become unreadable in the final reduction. As to styles of lettering, a clear free-hand letter is the best, and several good text-books are published which tell all about the methods to be followed to produce such letters. It is hardly necessary to say that the lines and letters should be heavier in the body than for ordinary drafting purposes, the exact thickness depending upon the proposed reduction in size. If the illustrations are photographic, to be reproduced by the "half-tone" process, these photographs should be clear and sharp and not too large. A safe general rule would permit a reduction ranging from one-third to two-thirds off the original: that is, a photograph 9 ins. wide might be reduced to from 6 to 3 ins. in width. Silver prints are preferable to platinum and other prints. The best photographs obtainable should be used; clear, sharp and with good contrasts of light and shade. Pictorial effects are desirable, but for most technical books the photographs chosen should really illustrate and supplement rather than ornament the book.

With the size of the illustrations relatively fixed, their position in the manuscript should be carefully located by numbers; and each drawing should carry this same number and the full and final title below it. In most cases, however, this title would eventually be set up in type.

The final size of illustrations depends somewhat upon the importance of the subject, but more upon the space necessary for a clear presentation of it. A simple diagram with a few reference letters upon it can be reduced to a relatively small size and be introduced into the body of the text to which it relates. It is much more useful in this place than if it were made so large as to occupy a page, and is more readily referred to. This same rule holds good for much illustrative matter. Plates, or illustrations printed on one side of the paper only, and inserted between printed pages are sometimes necessary, particularly in the case of maps, diagrams or the reproduction of large scale drawings having much detail, but they may generally be avoided by proper care in the selection and preparation of material for reproduction. Folding plates, as every user of a book knows, are a nuisance, but fortunately they are even less necessary than ordinary full-page plates. Illustrations on full-page plates and also those which occupy a page of text, need not be limited to the size of the type text, but may extend into the margins, thus giving yet more leeway in avoiding the use of plates. Of course, it will be understood that plates may sometimes be introduced for special purposes, such as the desire to use a better quality of paper for fine half-tone or other engravings than for the body of the book.

A discussion of the literary features of technical books is outside the scope of this article. But so many technical books are defective in style and utterly devoid of literary merit that this much may be said merely to put or keep authors on their guard: Writers of technical books are supposed to have something to say that is of value to busy technical men, and it is well to say it in a clear and concise form, with as little extraneous matter as possible. The "best style" is a presentation of the subject in good, clear-cut English by one who thoroughly understands himself, but who does not assume that all of his possible readers are equally well-informed. Naturally, the treatment will depend somewhat upon whether the author proposes to issue a book that will be useful to the beginner as well as to the more trained engineer or intends to appeal only to a small class of experts.

The writer should submit a form of title page, which may subsequently be modified, however, by technical considerations. And the author should arrange his table of contents and chapter heads, as he should best know what he is talking about and what are the important heads of his subject.

Proofreading demands careful attention. The author who is inexperienced in the art can readily get a few simple directions from his publisher or elsewhere. If his manuscript was typewritten, as already urged, and subsequently revised with great care, corrections on the proof will be reduced to a minimum. Additions to or material alterations in the proof may require the resetting of the type of a whole paragraph, particularly where machine instead of hand composition is employed. Great care should be taken to indicate all errors or desired changes on the first or galley proofs, since changes on the final or page proofs are likely to be very troublesome and expensive, possibly occasioning not only the resetting of type which has been mentioned, but also the rearrangement of the pages and, in the case of electrotypes, cutting or even remaking the plates. Where words or lines are changed it is often possible to make the substitute matter of the same length as the original, thus obviating some of the troubles just indicated. It is well worth while for authors to heed these cautions, since every change in the proof may create a new error, and since it is customary for publishers to charge the cost of alterations, above a certain maximum amount or percentage, to the author.

The index is a very important part of a book, but unfortunately it is often very unsatisfactory and sometimes almost useless. This subject has already been discussed in Engineering News of April 28, 1898, and in the Engineering Literature Supplement of August 20, 1903, and to these editorials readers are referred for detailed suggestions. It may be said here that the secret of good indexing is the intelligent selection of keywords for each topic, words that are likely to suggest themselves to the seeker after information under the several topics, and that with this word selected every reference under that head should be included.

This general subject might be extended to greater length, but enough has been said to show to the writer of technical books who does not already know it that thought and care expended in advance of the presentation of a projected book to the publisher will be beneficial to himself and to the publisher, and will likewise result in advantage to the buyer and reader.

*Draftsmen and photo-engravers indicate reductions in linear measurements, instead of by areas. A one-half reduction in length, obviously, is a three-fourths reduction in area.

CORRESPONDENCE.

Richardson's Modern Asphalt Pavement.

Sir: With many others interested in good asphalt pavements, I have read Mr. Clifford Richardson's book upon that subject, and also Mr. S. Whinery's review of the book in your issue of June 15, 1905.

Through many pages and chapters devoted to soils, drainage, foundation, base, concrete, sands, cement, binder course, etc., Mr. Whinery follows the author with cordial approval. We are finally, however, pained by a discordant note. The pleasing harmony disappears. They agree about sands as if they had played together upon the same sand heap when they were boys, but when asphalt is reached, they stand like Jap and Russ with drawn swords in Manchuria.

Mr. Richardson claims Trinidad asphalt to be best to produce successful pavements, while Mr. Whinery stoutly maintains it to be unsafe and objectionable.

In reference to another asphalt, that obtained from refining the asphaltic oils of California, their pleasing accord is again in evidence. They agree that the product of Trinidad Lake, a combination of asphaltic bitumen, earth, etc., should be called asphalt, while the California bitumen should be called "Residual Pitch." Both admit that it sometimes produces excellent pavements, but claim that it is a by-product, often carelessly refined and frequently subjected to excessively high temperatures in process of refining. May I point out a few facts:

(1) That every known asphalt is a product of asphaltic petroleum.

(2) That in the asphalt deposits of Trinidad and Venezuela, the lighter oils have evaporated under the rays of a tropical sun, while in California the same result is obtained by refining.

(3) Both classes of products have to be refined: one to get rid of earthy matter and water; the other to separate it from oils.

(4) That carelessness in refining the California product is rare; the business success or failure of the refiners is at stake and both Messrs. Richardson and Whinery are aware that no mined asphalt ever ran so chemically uniform as the product of the asphalt refineries of California.

(5) That asphalt is one of the most important products of California petroleum, often amounting to from 25 to 60% of the whole, and some refineries produce nothing else. To call this a by or residual product is an absurd misuse of language.

Very truly yours, Cal. Asphaltum Sales Agency,
F. Condit.

17 Battery Place, New York, June 20, 1905.

(The foregoing letter has been submitted to the reviewer of the book in question. His reply follows.—Ed.)

Sir: In so far as the communication signed "Cal. Asphaltum Sales Agency" (which you have kindly submitted to me) relates to matters of engineering interest to your readers, I am glad to comment upon it.

The question is not upon the intrinsic suitableness or value for paving purposes of bitumen obtained from asphaltic petroleum oil, but upon the character and quality of the product as found upon the market.

If the reduction were brought about, as in the case (probably) of most other asphaltums, by natural evaporation, or even by the application of moderate artificial heat, most of this kind of bitumen would be of unexceptionable quality. But the greater part of the product now on the market is the result of destructive distillation of the oil at temperatures ranging all the way from 700° to 1,100° F., and nothing is better settled than the fact that such temperatures "crack" or chemically disintegrate the bitumen.

In the asphalt paving industry it has been considered essential that the asphaltum shall not be heated to a temperature over 400° F., and most cities restrict the allowable temperature to a still lower figure. Such a restriction, if not wholly unjustifiable and absurd, must, alone, logically exclude materfal that has already been exposed, in the process of manufacture, to temperatures of from 700° to 1,100°.

It is, I believe, conceded that the primary object of the distillation from which this "residual pitch" results is to obtain the valuable lighter oils in the crude material, and not to obtain paving bitumen. Bitumen thus obtained is a residual or by-product as truly as is the coke from gas retorts. As might be expected, it is found to vary materially in quality with the degree of heat to which it has been exposed, and the care with which the process has been carried on. Furthermore, the product from oils of varying character, distilled at different localities and works, by different people, and under other varying conditions, but sold under the same trade name, could not reasonably be expected to be of uniform and homogeneous quality.

It is not denied, I believe, that the stock offered or sold for paving any single street may be made up from the products of several different refineries, located at different points and dealing with oils of different quality. Neither the ordinary nor the trained observer can usually detect the difference in quality by sight, and it usually requires an expert chemist to separate the good from the bad in the laboratory; and to thus examine every barrel of every shipment would be impracticable.

Under these conditions cities can safely pursue one of two courses: They may exclude the use of this questionable class of bitumens altogether. This is the simplest, and where there are a sufficient number of other good asphalts on the market to maintain competition, the safest course. Or they may require that bitumen of this class shall be manufactured under specifications that will insure its freedom from injury by overheating, and under other necessary regulations, all subject to the direction of competent inspectors appointed by the cities; and as the greater part of the product is manufactured at points distant from eastern cities and the expense of proper inspection would therefore be greater than in the case of other asphalts, it would be fair that a reasonable share of this cost should be borne by the producer, or by the contractor who wishes to use this kind of material.

This is a brief outline of what I believe to be the position taken by the leading asphalt experts in this country. They do not object to California oil bitumen *per se*, but to material as it is now manufactured and found upon the market. S. Whinery.

95 Liberty St., New York, July 8, 1905.

The Professional Papers of a Well-Known Engineer.

Reviewed by H. G. Prout.*

THE PRINCIPAL PROFESSIONAL PAPERS OF DR. J. A. L. WADDELL, CIVIL ENGINEER.—Edited by John Lyle Harrington, Civil Engineer. New York: Virgil H. Hewes, 245 West 107th St. Cloth; 6 × 9½ ins.; pp. 991; folding and other plates, and text illustrations. $5.

It is not necessary to introduce Dr. Waddell to the engineering public. His courage and energy, his intelligence and versatility have made him as widely known as any man in the profession. He has not only designed and constructed, but he has written and talked, all with originality, vigor and enthusiasm. He is a doctor of science of McGill University, a doctor of laws of the Missouri State University, a Knight Commander of the order of the Rising Sun of Japan, to say nothing of the degree of Civil Engineer from the Rensselaer Polytechnic Institute. So it is safe to assume that the reader knows pretty well how he writes and talks and works and what he thinks. If not, it is the reader's fault, for Doctor Waddell lives in the open. It is one of the delights of his life to stand up and be fired at. An important part of his considerable service to the profession has been in drawing the other man's fire and making the other man reveal his position.

The substantial volume now before us is made up of occasional papers and addresses by Doctor Waddell. These are expanded by introductory notes and comments and in many cases are added the discussions of these papers by other engineers on various public occasions. This method of treatment gives the reader the benefit of the spirited challenging of criticism, which is characteristic of Dr. Waddell's temperament.

There are, in all, 22 of these papers and addresses, and of these 11 are concerned, principally, or entirely, with the education of engineers and with their preparation for life. Early in his life Mr. Waddell taught for two years at the Rensselaer Polytechnic Institute and at 28 he went to Japan to teach the young idea how to shoot, and now the world stands amazed at the result. His educational papers therefore set forth at once the opinions of a teacher and of a busy and successful practicing engineer. Moreover, they have brought out a good deal of discussion from teachers and from practitioners, which is collected in this volume, and thus we get a variety of opinion, all worth considering and much of it weighty. It would be unprofitable to attempt any summary of the educational views of Dr. Waddell or of his critics. The field covered is much too vast. Of the 991 pages of the volume, 230 are filled with the consideration of engineering education in general and in detail; as a means of securing exact technical knowledge, and as a way of developing intellectual power and moral sense and force. Reading these papers and discussions, one is impressed with the noble conception of engineering as a profession which has spread abroad within recent times—within, let us say, the last quarter of a century. Such a conception a few men have had for many years, but more recently it has spread fast through the profession, and is even slowly penetrating the dark regions outside. The range and quality of the knowledge which the engineer must possess, the intellectual breadth which he must have and (most important of all) the moral stamina developed in the study and practice of his profession are suspected by few outside of the profession and are realized by only a small percentage of those within it. It is not claimed that all of those who take part in the discussions here collected realize all that engineering is, and should be, and will be—far from it; but one participant illuminates (or at least suggests) one phase, and another one suggests another phase, and so together they help toward the complete and adequate conception.

Aside from the educational papers, that on "Some Disputed Points in Railway Bridge Design" is probably the most important paper in the volume. This, with the discussion and the later comment, fills 188 pp. Some 41 engineers take part in the discussion and amongst them are the most eminent bridge designers in the country. It was a rare and remarkable thing to get such a discussion of a professional paper and there is no doubt that this did much to advance and to standardize details of practice. It was a fine example of Dr. Waddell's courage and enterprise to thus challenge the opinion of his contemporaries and get them to speak out in meeting. We suspect that back of it all is a certain sense of humor in the enterprise. This paper and the discussion are reprinted from the Transactions of the American Society of Civil Engineers.

The paper on "Elevated Railroads" (183 pages) is also important, and that, too, will be remembered as one of the "American Society" papers. It treats in great detail of the problems in design and construction of elevated railroads, and is copiously discussed. Some day, when people again recognize that there are places for elevated railroads, this will be a useful monograph on the subject.

Some of the other topics treated in the papers are "General Specifications of Highway Bridges of Iron and Steel"; "Compromise Standard System of Live Loads for Railway Bridges"; "Determination of the Safe Working Stresses for Railway Bridges of Iron and Steel"; and "The Halsted Street Lift Bridge." This last is an excellent description of a novel and ingenious design, skillfully executed, which most engineers think could have been carried out cheaper and better in some other way. Doubtless the reader will remember it.

Few engineers have written as much as Dr. Waddell; but many have written enough to make a respectable volume. The reviewer has often thought that it is a loss to the profession that they do not assemble their "fugitive pieces" and edit and expand them and make them readily available.

*First Vice-President and General Manager, Union Switch & Signal Co., 143 Liberty St., New York City.

AMERICAN STREET RAILWAY INVESTMENTS.—Published annually by the Street Railway Journal, for the use of Bankers, Brokers, Capitalists, Investors, and Street Railway Companies. Twelfth Annual Volume. 1905. New York: The McGraw Publishing Co. Cloth; 9½ × 13¼ ins.; pp. 415; folding and other maps. $5.

The new features of the latest issue of this annual are (1) the use of different styles of type to distinguish leased or subordinate from independent companies, and (2) the inclusion in the index of underlying companies, with bonds outstanding, even though such companies no longer have a legal existence. Of course the various reports have been revised for this issue; besides this, reports of new roads are included, and some of the old roads have for the first time supplied statements of earnings. The only summaries given show gross receipts for 1903 and 1904. A total of 415 companies, grouped according to the amount of receipts in 1904, are included in these summaries.

A Third Edition of Stodola's Steam Turbines.

Reviewed by Storm Bull.*

DIE DAMPFTURBINEN.—Mit einem Anhange über die Aussichten der Wärmekraftmaschinen und über die Gasturbine. By Dr. A. Stodola, Professor at the Federal Polytechnic School at Zurich. Third edition, greatly enlarged. Berlin: Julius Springer. Cloth; 7 × 11 ins.; pp. 454; folding plates, many text illustrations, and three lithograph tables. 20 marks; American price, $8.

This third German edition of the now famous work of Dr. Stodola is in a great many directions a new book. That a very large amount of additional material has been included in this new edition is evident from the fact that it is nearly double the size of the second edition. It is also very evident that the author is an indefatigable worker in the field covered by this book, from the amount of new experimental work, the results of which are given for the first time in this book, and also from the several theoretical investigations of various details and of a fundamental nature by the author and included in this new edition. Although quite a few books on the steam turbine have appeared during the last year, yet there is no doubt in the mind of the reviewer that Dr. Stodola's work in this last edition is without a peer. It has been improved in a great many ways and hardly a chapter has been left untouched. The changes and improvements are as numerous in the theoretical part as in the practical part of the book. Among the additions to the theoretical portions may be mentioned the complete theory of the many-stage "velocity" or "pressure" turbine, as it is called by the author, this class of turbines having received only a very summary treatment in the earlier editions. The various methods for representing graphically the condition of the steam are very much more fully described in this edition, the entropy charts of Mollier and of Boulvin, as well as the thermodynamic chart of Praell, being given. Because of various experiments carried out by Dr. Stodola, he concludes that the formulæ for the computation of rotating disks deduced in this book "may be used with perfect confidence," as he expresses himself in the perface.

In the practical part of the book the greatest addition is in the reproduction of detailed drawings of a number of new successful European turbines. Among these are the following ones: The turbine made by the Allgemeine Elektrizitats Gesellschaft in Berlin; by Gebrüder Sulzer in Winterthur; by the Gesellschaft für Elektrische Industrie in Karlsruhe; by the Maschinenbauanstalt "Union" in Essen. Mention should also be made of the new vertical Rateau turbine made by the Maschinenfabrik Oerlikon, in which the steam starts from below and flows upwards, no doubt for the purpose of reducing the pressure on the step-bearing. Detailed drawings are also for the first time given of the Zoelly turbine made by Escher & Wyss in Zürich. The Sulzer turbine shows a very interesting design, it being a combination of a velocity and a pressure turbine. Because of the change of direction of the flow of the steam the pressure in the bearings in an axial direction is almost entirely neutralized. That a firm like Sulzer Bros., who, taken altogether, have probably the best reputation in the world as builders of reciprocating engines, have begun the manufacture of steam turbines, shows conclusively the immense progress which these motors have made during the last few years. The only turbine of note of which detail drawings are not shown is the Parsons, presumably because the manufacturers have not been willing to let the author reproduce them. The reviewer cannot help expressing his surprise that the designers of the new turbines described in the book, like that of Sulzer and of the Allgemeine Elektrizitats Gesellschaft, should have been willing to have their working drawings reproduced in this manner; we are certainly not accustomed to such things in this country. The author, however, remarks that he is of the opinion that such reproduction cannot hurt a really able designer. The reviewer is as firmly convinced that the technical public should be very grateful for the liberality shown by the manufacturers and designers in this direction. The detailed drawings of the turbines are mostly shown on a comparatively large scale, on folded plates, and the mechanical execution of these plates is excellent.

The question of wear of the blades has been considerably discussed during the last few years. Some experiments carried out by Sulzer Bros. and described in the book conclusively show that this wear is almost exclusively due to the particles of water in the steam. For many-stage turbines such wear is quite insignificant, but for one-stage turbines, like that of the De Laval, it is quite serious. Sulzer Bros. have shown that such wear disappears almost entirely when highly superheated steam is used, even if the metal of which the blades are made is quite soft. Sulzer Bros., however, use a nickel steel with 25% nickel.

As already stated, the book is almost a new one. The improvement is so great that the reviewer cannot help feeling that it is a pity that an English translation of the second edition was brought out only a short time ago, at least if this translation should stand in the way of publishing a translation of the third edition.

The price in Germany, 20 marks, equal to $5, is certainly a more than reasonable one; in fact so low that the reviewer would like to express the hope that the reading technical public in the United States might become as numerous as in Germany, in which case the publishers of technical books surely would be very glad to reduce the prices of their books to somewhat near those prices which the German publishers get for theirs.

It is to be expected that this book will find a very wide sale, as nobody especially interested in steam turbines can afford to be without a copy.

*Professor of Mechanical Engineering, University of Wisconsin, Madison, Wis.

A Synopsis of Mechanical Test Instruments and Procedure.

TECHNISCHE MESSUNGEN.—With Special Reference to Machine Tests. By Anton Gramberg, Dantzig. Berlin, Germany; Julius Springer. Cloth; 6¼ × 9¼ ins.; pp. 222; 181 figures in the text. 6 marks; American price, $2.40.

A manual of unusual and distinctly meritorious character presents itself here under a somewhat misleading title: "Technical Measurements." The book does not deal with all classes of measurements required in technical work, but only with those of mechanical engineering, and in this field specifically with those involved in testing the performance of engines and other machines (except such measurements as are purely electrical). Moreover, it does not discuss testing or tests, but confines itself to describing the instruments used for observing the different quantities involved, such as length, temperature, pressure, heating value, humidity, mechanical power and the like. This restricted field is covered at once concisely and thoroughly. Each of the various quantities which need to be measured is taken up, in systematic order; the factors that influence it are mentioned; instruments for measuring the quantity are described; the manipulation or methods of using the instrument are discussed, and in the same connection the precautions essential to accuracy are noted.

Three introductory chapters, which precede the discussion of individual measurements and instruments, contain matter of much value, matter which characterizes the author's entire treatment of the subject. They deal with preliminary ideas, such as the nature and purpose of measurement, units of measurement, units and compound quantities, dimensional homogeneity of equations, the relation between degree of accuracy of the component measurements and the results, fundamental factors affecting the accuracy of measuring instruments, and other general considerations. While this matter covers but 17 pages it is supplemented by many critical remarks, notes of desirable precautions or factors influencing accuracy that are scattered through the remainder of the work. As an example we may instance the matter of interaction between a driving machine and a load brake used to measure its power output. The author here shows, in diagrams, the speed-torque characteristics of various prime movers (steam-engine, electric motor, turbine) and of various forms of load brake (Prony brake, hydraulic friction brake, eddy-current magnetic brake), and points out that a stable test condition, permitting accurate measurement, results only when the characteristics of prime mover and brake cross each other at a large angle.

The measurements discussed at length in the main part of the book concern the following quantities: Linear dimension, 8 pp.; Areas (planimeters, Simpson's rule), 7 pp.; Time, 1 p.; Velocity (revolution counter, tachometer, Pitot tube), 17 pp.; Weight and volume (scale, hydrometer, gas balance, orifices, weirs, current meters, water and gas metering, etc.), 42 pp.; Pressure of Gases (pressure and vacuum gages, etc.), 16 pp.; Force and Power (dynamometers, brakes, steam indicator), 55 pp.; Temperature, 12 pp.; Heat (calorimeter), 2 pp.; Fuel Value, 17 pp.; Moisture content, 9 pp.; Composition of Gases, 11 pp. Appended to the text is a list of references to other books and to manufacturers of instruments and apparatus, classified for the various chapters. An index completes the volume.

The mechanical equipment of the book is excellent, alike in text, illustrations and assemblage. The size and scope of the book are rather modest, due no doubt to the author's evident purpose of restricting himself rigidly to the field above outlined. It seems quite likely that a widening of the scope would make the book even more valuable. Still excluding electrical measurements and instruments, many other instruments of engineering testing might be grouped with those here treated, without either making the work heterogeneous or too much extending its size. A similar work in English would be a welcome addition to our technical literature; the field is not wholly clear, but the direct object of the present book is not met by any English work with which we are acquainted.

THE PRESENT STATUS OF THE USE OF STANDARD TIME.—By Edward Everett Hayden, Lieut.-Commander, U. S. N., Head of the Department of Chronometers and Time Service, Volume IV., Appendix IV., Publications of the United States Naval Observatory (Second Series). Rear-Admiral Colby M. Chester, U. S. N., Superintendent. Washington, D. C.: Pub. Doc. Paper; 9¼ × 11½ ins.; pp. 28.

This report takes up the development of the standard time system adopted by the United States in 1883, on the initiative of the American Railway Association. The meridians of 75°, 90°, 105° and 120° West from Greenwich then became the time meridians of Eastern, Central, Mountain and Pacific standard time, respectively, with exactly one hour intervals between. This system has now been extended to our remotest possessions, and has spread over the civilized world, although a few nations still use their own prime meridians instead of that of Greenwich.

A conversion table is here presented, for converting the time of one country into that of another, without any confusion regarding the proper date. This table gives the hours, minutes and seconds earlier or later than Washington or Eastern standard time. The arrangement is by countries, and the variations are given both for Washington and Greenwich.

In advancing a common and harmonious international system of time, now made so necessary by the rapid extension of railways, telegraphs, cables, etc., daily telegraphic time signals have been sent out since August, 1865, from the U. S. Naval Observatory; and these now reach every part of this country. But on Dec. 31, 1902, a special series of time signals were first sent out, marking the exact instant of the beginning of the New Year for each of the four great standard time belts of the United States. This plan has been taken up energetically by the telegraph and cable companies, and now when special time signals are sent out the Observatory standard clock may fairly be said to be heard in "the remotest ends of the earth." These signals from Washington have reached Mexico in 0.11s.; Manilla, in 0.37s.; Sydney, in 2.25s., and Argentina in 7.70s.

A table given shows that 36 nations have adopted standard time, and 20 of these use systems based on the meridian of Greenwich; and no two other nations agree. Another table gives abstracts of the system of time in actual use in various countries, with the variations in time. The final table is a list of the dividing points, or North American Time Standard Sections, with the time in use in each, as adopted by the American Railway Association.

An English Translation of Weisbach and Herrmann's Mechanics of Air Machinery.

Reviewed By Henry T. Bovey,* M. Inst. C. E.

MECHANICS OF AIR MACHINERY.—By Dr. Julius Weisbach and Professor Gustav Herrmann. Authorized Translation, with an Appendix on American Practice, by Amasa Trowbridge, Ph. B., Adjunct Professor of Mechanical Engineering, Columbia University. New York: D. Van Nostrand Co. Cloth; 6 × 9¼ ins.; pp. 286; two folding plates, and 91 figures in the text. $3.75 net.

The translation of Weisbach and Herrmann's Mechanics of Air Machinery, by Trowbridge, has supplied the English public with a large amount of new and important information respecting the difficult problem of ventilation. The whole problem of the ventilation of buildings is one of the utmost importance to health and safety, and in a country in which, for the greater part of the year, at all events, it is necessary to depend upon artificial ventilation, a method of supplying fresh air, based upon reliable experiments and principles, becomes a pressing need. This need is now occupying the minds of many engineers, and to these the present treatise should afford no little assistance. The mathematical treatment of these problems is in accordance with the opinions of the best informed engineers, who believe that it is possible to base upon mathematical theories the manipulation and supply of fresh air, without causing discomfort to those who are subject to its influence.

Weisbach's works illustrated this point very fully and are now so well known that every production of his pen is worthy of most careful study. In general terms it may be said that, in the present treatise, the part for which Weisbach and Herrmann are responsible treats of ventilation, blowing engines, compressors, rotary blowers and fans. The treatment of the subject in the earlier portions is of an almost purely academic character and requires a more than average degree of mathematical knowledge. While indicating a great advance on the old "rule of thumb" system, this mathematical method makes the book of less service than it might be to the average practical designer of fans and blowers.

It would also be an advantage to the practical designer if in the appendix the information regarding experimental work with fans were greatly increased. It is hardly necessary to say more of the latter part of the book, which is largely made up of illustrations of modern practice.

In order to meet the needs of the mathematician, and without wishing to question the values assigned by Messrs. Weisbach and Herrmann to the various coefficients, it is to be hoped that in another edition further information may be provided as to the data on which they are founded. The articles dealing with the movement of air through blowing engines are more complete than the articles in the earlier portion of the work, while the illustrative problems are given with an amount of detail which throws considerable light upon the subject.

On the whole it may be said that the work supplies a much needed discussion of a very important branch of mechanics, which may be expected to lead to further investigation into the principles on which the design of fans and blowers should be based.

Machine Tools and Tool Making.

Reviewed by Wm. W. Bird,† M. Am. Soc. M. E.

MACHINE TOOLS AND WORKSHOP PRACTICE.—For Engineering Students and Apprentices. By Alfred Parr, Instructor in Fitting and Machine Shop, and Forge, University College, Nottingham. With an Introduction by William Robinson, M. E., M. Inst. C. E., Professor of Engineering, University College, Nottingham. London, New York and Bombay: Longmans, Green & Co. Cloth; 5¾ × 9 ins.; pp. 444; 510 illustrations, mostly in the text. $4.

AMERICAN TOOL MAKING AND INTERCHANGEABLE MANUFACTURING.—A Treatise upon the Designing, Constructing, Use, and Installation of Tools, Jigs, Fixtures, Devices, Special Appliances, Sheet-Metal Working Processes, Automatic Mechanisms, and Labor-Saving Contrivances; together with Their Use in the Lathe, Milling Machine, Turret Lathe, Screw Machine, Boring Mill, Power Press, Drill, Sub-Press, Drop Hammer, etc., for the Working of Metals, the Production of Interchangeable Machine Parts and the Manufacture of Repetition Articles of Metal. By Joseph V. Woodworth. New York: The Norman W. Henley Publishing Co. Cloth; 6 × 9 ins; pp. 535; 601 figures in the text. $4.

The first of these two books is by an Englishman, and the book itself relates wholly to British practice, except for the chapters on milling and grinding, which are from the practice of the Brown & Sharpe Co., and the chapter on turret work, which is devoted largely to the description of the Jones & Lamson flat turret lathe. The other chapters treat of the various processes of the forge and machine shops, together with descriptions of the several machines used in each, for general manufacturing purposes. The book is poorly arranged, the chapters are not in logical order, and many of the methods of manufacture seem crude and out of date. Too much ground is covered to make the book of real value for engineering students except for general reading. With chapters on materials of construction and power transmission, subjects in which the author is not an authority, together with descriptions of machine tools which can be found in trade catalogues, the book is loaded with material for which few will care to pay. The book, however, has many valuable suggestions and can be read with profit by engineering students and those interested in machine shop practice.

The second book is purely American and of an entirely different character than the first one. Here we have a treatise on toolmaking, chiefly that part which relates to interchangeable manufacturing and the duplicating of parts, written by a man who knows just what he is describing.

A clear and systematic arrangement of the several chapters carries the reader from one method to another in a logical way. The style is clear and manner of presentation is pleasing. The book is a good exposition of the use and construction of jigs and special tools. Attention is called to the varying degree of accuracy needed for such work and the best methods for numerous cases are clearly shown.

The chapters on punching and drawing dies and the methods of their use are full of valuable points and make up the second part of the book. The entire work is full of reading matter which can be found in no other book, and no designer, superintendent or toolmaker in any up-to-date shop should fail to have a copy of this book in his library.

*Dean of the Faculty of Applied Science, McGill University, Montreal, P. Q.

†Professor of Mechanical Engineering and Director of the Washburn Shops, Worcester Polytechnic Institute, Worcester, Mass.

MOODY'S MANUAL OF RAILROADS AND CORPORATION SECURITIES.—Sixth annual number, 1905. New York: Moody Publishing Co. Cloth or leather; 6½ × 9½ ins.; pp. 2542; folding and other maps. Cloth, $10; full leather, $12.

This annual has increased in size by leaps and bounds until it now has ten sections and includes more than 2,500 pages, not counting advertisements. Steam and electric railway, lighting, water, telephone and telegraph, industrial and miscellaneous, mining and oil, bank and trust companies, are all represented by separate sections. Judging by the water companies the sections are very incomplete as to numbers, since many less than two hundred of two thousand or more companies are given. In such a work the importance of the companies listed is of far more moment than the number, and judged by this standard the book makes a far better showing. Evidently the publishers must stop short of numerical inclusiveness when what they do give makes such an immense volume.

A Revised Treatise on Telephone Practice.

AMERICAN TELEPHONE PRACTICE.—By Kempster B. Miller. Fourth Edition, Enlarged and Entirely Rewritten. New York: McGraw Publishing Co. Cloth; 7 × 10½ ins.; pp. 888; 643 figures in the text. $4, net.

In thoroughly rewriting this well-known manual on the mechanism of telephony, the author has accomplished his task with a thoroughness rare in revisions. The result is a book just twice the size of the first edition, published but six years ago. The added matter includes, first, a full treatment of common battery or central energy telephone systems, a good chapter on automatic exchanges, and about two hundred pages on constructional and administrative details of telephone work, which had been insufficiently (or not at all) covered in the earlier editions. This added matter makes the book a very satisfactory treatise on telephony from the mechanical or apparatus side. About one hundred pages on transmission line construction, repeated with less degree of revision from the earlier editions, represent this branch of the art fairly well, though less fully than the corresponding sections in one or two other works.

The two primarily essential elements of the telephone, the transmitting and receiving instruments, discussed in the first portion of the book, are treated descriptively, as in other books on the subject. Little or nothing is given in the way of results of analytical study of these instruments. This is not chargeable to the author as a fault, however, for no such study worth mentioning has been made, and the development of the various forms of instrument has been accomplished by general reasoning and by trial, unaided by analytical experimenting. In consequence little is known of the actions in receiver and transmitter in detail, and their treatment in a book like the present one is necessarily purely descriptive. However, the main development and all the intricacy of the subject lie in the switching apparatus, and this phase of the subject is well covered. The book, as a standard treatise on telephone practice, needs no commendation on its part beyond acknowledgment of the author's industry and thoroughness in the present revision.

THE INDUSTRIAL PROBLEM.—Being the William Belden Bull Lectures for the Year 1905. By Lyman Abbott. Philadelphia, Pa.: George W. Jacobs & Co. (1216 Walnut St.). Cloth; 5 × 7½ ins.; pp. 190. $1, net.

As was fitting in a series of lectures designed primarily for divinity students these addresses consider the industrial problem from the viewpoint of applied Christianity. The problem is first reviewed in a general way and then a threefold solution is presented: (1) Political, or government regulation of capital and labor; (2) economic, or reorganization of industrial society so as to make at least more unified tool owners and tool users; (3) ethical, or a moral and spiritual regeneration of the individuals composing society, which is obviously the fundamental proposition of the three. On the whole, the views will not be considered radical by those who reflect upon them dispassionately; and for the most part they might as properly have been expressed before any thoughtful, intelligent audience as before theological students.

TRAUTWINE'S
CIVIL ENGINEER'S POCKET BOOK

18th Edition, 1904
$5.00

JOHN WILEY & SONS
Scientific Publishers
43 and 45 East Nineteenth Street
NEW YORK CITY

Bacteriology and Public Health.

BACTERIOLOGY AND THE PUBLIC HEALTH.—By George Newman, M. D., F. R. S. E., D. P. H., Formerly Demonstrator of Bacteriology in King's College, London, Etc., Medical Officer of Health of the Metropolitan Borough of Finsbury, Joint-author of "Bacteriology of Milk." Third Edition. Philadelphia, Pa.: P. Blakiston's Son & Co. Cloth; 6 × 9 ins.; pp. 497; 31 figures and 48 text illustrations.

As a general treatise on the relation between bacteriology and public health this book deserves hearty commendation. It is up-to-date and it takes cognizance of much of the best American work, as well as the literature and practice of Great Britain, France and Germany. The author states in his preface that although nominally a third edition of his "Bacteria in Relation to the Economy of Nature, Industrial Processes and the Public Health," the book is essentially a new one, several chapters having been added and the whole enlarged and revised.

After a general chapter on bacteria, the author takes up bacteria in water, air, fermentation, sewage and its effluents, milk and its products and in other foods, including oysters, cockles and clams, meat, ice cream, bread and water cress. A general discussion on bacteria and disease serves as an introduction to a consideration of such specific diseases as tuberculosis, malaria, cholera, plague, leprosy, yellow fever, and anthrax. Immunity and antitoxins are next discussed and then disinfection. An appendix on bacteriological technic concludes the volume.

From the viewpoint of engineering and the public health the book contains much to commend and little to criticise. Some of the comments on the slow sand filtration of water seem to give undue weight to the chemical action of the "layer of scum and mud on the surface of" the filter beds. The mechanical filtration of water is omitted. This process is used far less in Great Britain than in the United States, but in view of its extensive use in this country and its use at York and Wolverhamption, England, to supplement slow sand filtration, and its use in one way or another in various Continental cities at least a brief discussion of it might be expected. Sewage treatment is considered more fully than water purification. The author gives more than usual credit, for a British writer, to the experimental work of the Massachusetts State Board of Health. In presenting an example of the septic tank the author chooses as an example the small or St. Leonard's installation at Exeter, instead of the much larger tanks subsequently built there, or some of the many tanks built elsewhere. Likewise, the descriptions of both the Manchester and Sutton works give little idea of the later and more important developments at those places. In the case of Sutton the author states that "there is no tank," whereas settling tanks approximating towards, if not actually being, septic tanks have been in use several years and interesting new filter beds have also been installed since the works, as described by the author, were built.

The section on milk is one of the best in the book. Some very instructive American examples of milk-borne epidemics do not appear to have come to the attention of Dr. Newman. Among these are an outbreak of some 80 cases and 13 deaths of typhoid fever on a single milk route at Montclair, N. J., ten years or so ago, and a later outbreak of diphtheria, at the same place. In the latter case, cultures from the throats of the milkers at the dairy from which milk was being supplied (a model dairy outside the town with a herd of several hundred cans) showed the diphtheria germs present in the throats of nearly twenty men.

It is somewhat surprising that practically nothing is said about the communicable nature of pneumonia. Possibly some of our American writers have laid to much emphasis on this subject, and it may be that recent figures purporting to show alarming increases in the mortality from this disease in a number of American cities have not been well founded.

The chapter on disinfectants is perhaps the least satisfactory one in the book. There are, however, several excellent recent treatises on this subject so the author may be excused for being brief here, although he can scarcely be excused for the lack of discrimination and definiteness in the paragraph on disinfecting excreta. Regarding the author's apparent preference for sulphur rather than formaldehyde gas as a room disinfectant, perhaps much could be said on both sides. In the United States the general practice among supposedly progressive boards of health is to use formaldehyde and to distrust sulphur.

In conclusion, we wish to be understood that our criticisms should not weigh against the book as a whole, which we consider a most valuable treatise for all classes of health officials and all others who wish to join effectively in the modern crusade against communicable diseases.

IMPORTANT BOOKS.

CEMENTS, MORTARS AND CONCRETES, Their Physical Properties, by Myron S. Falk, Ph. D., Instructor in Civil Engineering, Columbia University. Cloth, 6 x 9 inches, 184 pages, price $2.50.

"This is a valuable contribution to American cement literature. It covers almost every kind of test to which concrete can be submitted to ascertain its identical properties as a material of construction. The text is clear, lucid and to the point. The book should be in the hands of all engineers engaged in concrete construction."—Journal Western Society Engineers.

ROCK EXCAVATION—METHODS AND COST, by Halbert P. Gillette, Author of "Earthwork and Its Cost." Cloth, 5 x 7½ inches, 384 pages, price $3.00.

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MATHEMATICS OF THE PAPER LOCATION OF A RAILROAD, by Prof. J. C. L. Fish, Stanford University. Pamphlet 4½ x 7½ inches, 18 pages, price 25 cents.

The above or any other books on the market can be supplied promptly by **M. C. CLARK,** Publisher and Bookseller, 21 Park Row, New York

SEWERAGE AND SEWAGE PURIFICATION.—By M. N. Baker, Ph. B., C. E., Associate Editor of "Engineering News." Second Edition, Revised and Enlarged. New York: D Van Nostrand Co. Boards; 3¾ × 6¼ ins.; pp. 153. 50 cts.

The nature of the revision which this book has received is stated in the preface as follows:

In the nearly ten years that have elapsed since the appearance of the first edition of this little book the newer and so-called bacterial processes of sewage treatment have been announced, passed through an experimental stage and come into extensive use. Meanwhile the author has improved many opportunities to visit American sewage purification works, old and new, and, during 1904, spent several months abroad, chiefly in Great Britain, visiting sewage works and meeting a number of the men prominently connected with British progress in this field. As a consequence of the events named above, the section of this book which deals with the purification of sewage has been largely rewritten and somewhat extended. Few changes in the other section, on sewerage systems as contrasted with disposal works, have been deemed necessary.

STANDARD METHODS OF WATER ANALYSIS.—Report of Committee to the Laboratory Section of the American Public Health Association. Presented at the Havana Meeting, January 9, 1905. Chicago, Ill.: Journal of Infectious Diseases. Paper; 6¾ × 9½ ins.; pp. 141. $1. Cloth, $1.25.

The work here reported was virtually begun ten years ago and has been in progress ever since. Earlier preliminary reports are scattered in various publications and most of them are out of print or not generally available. The present report, so far as standards are concerned, supersedes the others. Besides the letter of transmittal, some historical matter and reprints of portions of an earlier report, there is given a tabular summary of the physical, chemical, microscopical and bacterial examinations for clear, colored, turbid and highly polluted surface waters; for ground waters; for waters before and after treatment by sand filters, mechanical filters, softening plants and iron removal plants; and for sewage before and after treatment. Next are given brief directions for collecting samples, including the time that may elapse between the collection and examination of samples under various conditions and for different purposes. The bulk of the report consists of descriptions of standard methods for making and recording all the examinations deemed necessary in studying water supply and sewage questions. These descriptions are not designed to take the place of manuals of water analysis, but to promote uniformity. Where a choice of methods may be desirable two or more procedures are described. The report contains practically nothing on the interpretation of examinations except comments to promote uniformity.

A large number of workers have cooperated with the committee in producing a most valuable report.

SUSPENDED MATTER IN SEWAGE AND EFFLUENTS.—By Gilbert John Fowler, D. Sc., and Edward Ardern, M. Sc. Reprinted from the Journal of the Society of Chemical Industry, Manchester Section, 15th May, 1905. (Address the senior author, Broad Oaks, Urmston, near Manchester, England). Paper; 5 × 7¼ ins.; pp. 19.

That the sludge problem is by no means solved as yet is forcibly shown when so eminent an authority as Dr. Fowler, with his practical experience in the management of the Manchester sewage works, presents a paper like this before a society of chemists. The opening sentence of the paper reads:

It is becoming more and more generally recognized that the real difficulty in the problem of sewage purification consists, not so much in producing a good effluent, as in finding a satisfactory method of dealing with sludge.

The suspended matters in sewage are classified by Dr. Fowler into (1) floating material and detritus; (2) finely disseminated solids; (3) matter in emulsion or colloidal matter. The paper before us records "*preliminary* observations," chiefly at Manchester, on colloidal matter in sewage and also in effluents from chemical precipitation, septic tanks, contact beds and continuous or percolating filters. The author concludes that

In addition to the ordinary sludge obtained by settlement of the sewage, the sewage chemist is faced with the disposal, ultimately, of the residue left after transformation of the colloidal matters in pseudo solution or emulsion.

That is, to the visible suspended matter in an effluent there is added, after the effluent stands awhile, a further amount of sediment. Dr. Fowler states that experiments are being made

to determine what proportion of these can be actually oxidized by bacterial activity, and what proportion will have eventually to be dealt with and removed from the filtering material by washing or screening.

The results of these experiments will be awaited with interest.

FILTRATION OF PUBLIC WATER SUPPLIES.—By R. Winthrop Pratt, Engineer, Ohio State Board of Health. Read at the Annual Convention of State and Local Boards of Health, Columbus, O., Jan. 27 and 28, 1905. Reprinted from the Ohio Sanitary Bulletin, January-March, 1905. Paper; 6¼ × 9¼ ins.; pp. 11.

SEWAGE DISPOSAL.—By George A. Johnson, Engineer in Charge Sewage Testing Station, Columbus, O. Presented and reprinted as above stated. Paper; 6¼ × 9¼ ins.; pp. 16.

These papers present a good general review of water and sewage treatment, respectively. A brief account of the Columbus sewage testing station is given by Mr. Brown.

The Law of Oil and Gas, Including Its Municipal Aspects.

THE LAW RELATING TO OIL AND GAS.—Including Oil and Gas Leases and Contracts, Production of Oil and Gas, both Natural and Artificial, and Supplying Heat and Light thereby, whether by Private Corporations or Municipalities. By W. W. Thornton, Author of "Railroad Fences and Private Crossings," etc. Cincinnati, O.: The W. H. Anderson Co. Leather; 6 × 9½ ins.; pp. cxl + 918. $5.

A layman might expect that a book giving the law on a subject would consist largely of citations from the statutes of the several States, but a lawyer generally draws a sharp distinction between legislation and law. To him a legislative enactment means little save an opportunity for litigation until it has been passed on by the highest court of jurisdiction. Following out this principle the volume before us consists chiefly of a systematized digest of the court decisions, State and United States, relating to the ownership, production, transportation and sale of petroleum oil and natural gas, combined with like decisions upon many phases of the production, distribution and sale of artificial gas. As elucidating the subject, many decisions relating to mining and to water supply and electric lighting are given. Since from the nature of the case not all of the many questions involved have gone or can ever go to the United States courts, the same question is often passed upon by two or more States and naturally enough the decisions do not always agree. In some such instances the author has given his own opinion, "for what it is worth," he says.

After a historical sketch of the development of the oil and gas industries in this country there is a general discussion of the legal status of oil and natural gas. Various phases of oil and gas leases and partnerships are then discussed in a number of chapters. Mechanics' liens, mortgages, eminent domain and transportation are next considered. The several chapters on legislative and municipal control of lighting, municipal franchises, contracts and ownership, the use of highways, the gas company and the consumer, meters, fixtures and the like contain many citations which while appropriate here have an important bearing on various questions other than those to which the book is primarily devoted. Among the subjects considered in the last part of the book are nuisances, leaks and explosions, injuries due to negligence, insurance and taxation. An appendix is devoted to forms of leases and agreements. In the way of foot notes, table of cases and the like the book follows the usual well-established forms for legal works. The book as a whole appears to be a creditable and useful production.

NOTES ON BRITISH REFUSE DESTRUCTORS.—With an Introductory Comparison of British Refuse Destructors and American Garbage Furnaces. By M. N. Baker, Ph. B., C. E., Associate Editor of "Engineering News." New York: The Engineering News Publishing Co. Paper; 4½ × 7 ins.; pp. 60; three figures in the text. 25 cts.

These Notes have been reprinted from Engineering News of April 13, 20 and 27, 1905. They are founded on observations made by the author during a trip abroad in 1904, and include descriptions of a few refuse destructors of the British type on the Continent and a large number in England and Scotland. The "Introductory Comparison" is designed to show, among other things, how American garbage furnaces might and should be improved.

GLASGOW MUNICIPAL ENTERPRISES.—(John Ure Primrose, Lord Provost.) Glasgow, Scotland: The Town Clerk. Cloth; 5½ × 8¾ ins.; pp. 147; illustrated. 2s., or 2s. 5d. postpaid to America.

Glasgow holds the enviable reputation of being one of the most enterprising and successfully governed municipalities in the world. This low-priced and well-written historical and descriptive account of these enterprises will doubtless receive a hearty and world-wide welcome. It was written primarily for those who attended the Sanitary Institute Congress held in Glasgow in July, 1904, but the preface to the volume as now issued is dated November, 1904. After a brief but interesting historical sketch of the city there are taken up the art galleries and museums, parks, libraries, city improvement buildings, hospitals, health department, sewage treatment works, baths and wash-houses, streets, city engineering department, refuse destructors, water-works, gas works, tramways, markets and slaughter houses, and other institutions of the city. Line drawings and half-tones supplement the text. The book as a whole is instructive and suggestive. A series of such volumes for the principal municipalities of the world would be very useful to a large number of people.

THE FINANCES OF GAS AND ELECTRIC LIGHT AND POWER ENTERPRISES.—By William D. Marks, Ph. B., C. E., M. Am. Inst. E. E. Philadelphia, Pa.: The Author, 218 The Bourse. Flexible cloth; 5 × 7 ins.; pp. 368; tables; two folding figures, and one map.

Although no hint of the fact is given in the book, this is an enlarged edition (125 pages increased to 368) of a volume bearing the same title. The earlier work was reviewed in this Supplement for Aug. 18, 1904. The author makes no claim of having produced a treatise. He has merely brought together a series of articles, reports and other writings on the subjects indicated by the title and on some phases of the management of light and power stations. The volume abounds with both theoretical and practical illustrative examples and contains statistical compilations and analyses of the operations of street railway and of lighting companies. As we said in our review of the first edition: The author urges "careful engineering study as a basis for fixing rates," and emphatically protests "against applying the methods of 'high finance' to public service enterprises." It may be added that he gives many hints for putting unprofitable works on a paying basis, and that the book contains a chapter on the "Finances of District Heating from Electric Plants."

ECONOMICAL STEAM ROLLING OF IRISH COUNTRY ROADS.—By E. A. Hackett, M. E., M. Inst. C. E., County Surveyor, Co. Tipperary, S. R. Belfast, Ireland: Irish Roads' Improvement Association (W. H. Alexander, 14 Lombard St., Hon. Secretary). Paper; 4 × 6¼ ins.; pp. 22. Three pence.

This little pamphlet should be of value to all engineers interested in the methods and cost of repairing macadam roads. Valuable cost data are given. The author shows that the "continuous system" of repairs is not so economic as the intermittent system and that macadam roads in Ireland require resurfacing about once every six years. The author favors the use of 15-ton rollers instead of 10 or 12-ton rollers for repair work. The pamphlet is an excellent addition to the meager literature of highway economics, and but one fault is to be found with it, namely, that it does not give the rates of wages, the price and amount of coal, and other items that would enable an American engineer to apply the data to work done in America at different rates of wages.

COAST EROSION.—And the "Case" System of Foreshore Protection. By Gerald O. Case (15 Tothill St., Westminster, S. W., England). London, England: The St. Bride's Press, Ltd. Paper; 8¾ × 11 ins.; pp. 15; 14 figures in the text.

This pamphlet describes the "Case system" of ocean shore protection by means of low wooden groynes. The groynes are essentially a series of low board fences, the posts being planked up about 2 ft. above the surface of the beach. As fast as the sand accumulates behind the groynes the planking is raised. Photographs and drawings illustrate the success of this method of shore protection in England.

TABLES AND OTHER DATA FOR ENGINEERS AND BUSINESS MEN.—Compiled by Charles E. Ferris, B. S., Professor of Mechanical Engineering, University of Tennessee. Fifth Edition. Knoxville, Tenn.: University Press. Leather; 3 × 5¼ ins.; pp. 240. 50 cts.

A variety of useful tables from many sources is here combined with short notes regarding the value of technical education, particularly "as a means of developing our undeveloped resources." At the suggestion of the compiler the advertisements at the back of the book "are so worded that they contain additional information." For a small pocket book, of handy size, this one contains many useful tables.

32
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87
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Described in a paper prepared for the Twenty-fifth Annual Convention of the American Water-Works Association, held at West Baden, Indiana, May 8 to 14, 1905

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Associate Editor "Engineering News"; Editor "Engineering Literature Supplement"

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Water Supply and Irrigation Papers.

WATER SUPPLY AND IRRIGATION PAPERS, U. S. GEOLOGICAL SURVEY.—Charles D. Walcott, Director; F. H. Newell, Chief Engineer. Washington, D. C.: Pub. Doc. Paper; 6 x 9 ins.

No. 108: Quality of Water in the Susquehanna River Drainage Basin. By Marshall Ora Leighton. With an Introductory Chapter on Physiographic Features, by George Buell Hollister. Pp. 76; four plates and seven text illustrations.

No. 110: Contributions to the Hydrology of Eastern United States, 1904. Myron L. Fuller, Geologist in Charge. Pp. 211; five plates and 33 text illustrations.

No. 112: Underflow Tests in the Drainage Basin of Los Angeles River. By Homer Hamlin. Pp. 55; seven plates and 30 text illustrations.

No. 114: Underground Waters of Eastern United States. Myron L. Fuller, Geologist in Charge. Pp. 285; tables, 18 plates, and 40 text illustrations.

No. 115: River Surveys and Profiles Made During 1903. Arranged by W. Carvel Hall and John C. Hoyt. Pp. 135; tables, four plates, and 18 text illustrations.

No. 116: Water Problems of Santa Barbara, California. By J. B. Lippincott. Pp. 99; tables, eight plates, and 17 text illustrations.

No. 117: The Lignite of North Dakota and Its Relation to Irrigation. By F. A. Wilder. Pp. 59; eight plates and five text illustrations.

No. 118: Geology and Water Resources of a Portion of East-Central Washington. By Frank C. Calkins. Pp. 96; four plates and 14 text illustrations.

No. 119: Index to the Hydrographic Progress Reports of the United States Geological Survey, 1888 to 1903. By John C. Hoyt and B. D. Wood. Pp. 253.

No. 120: Bibliographic Review and Index of Papers Relating to Underground Waters Published by the United States Geological Survey, 1879-1904. By Myron L. Fuller. Pp. 128.

No. 122: Relation of the Law to Underground Waters. By Douglas Wilson Johnson. Pp. 55.

No. 124: Report of Progress of Stream Measurements for the Calendar Year 1904. Prepared under the Direction of F. H. Newell, by H. K. Barrows and John C. Hoyt. Part I.—Atlantic Coast of New England Drainage. Pp. 157; two plates and one text illustration.

No. 126: Progress of Stream Measurements, 1904. Prepared Under the Direction of F. H. Newell, by N. C. Grover and John C. Hoyt. Part III.—Susquehanna, Patapsco, Potomac, James, Roanoke, Cape Fear, and Yadkin River Drainages. Pp. 125; many tables, 2 plates and 1 text figure.

No. 127: Report of Progress of Stream Measurements, 1904. Prepared under the Direction of F. H. Newell, by M. R. Hall and John C. Hoyt. Part IV.—Santee, Savannah, Ogeechee and Altamaha Rivers and Eastern Gulf of Mexico Drainages. Pp. 192; many tables, two plates and one text illustration.

No. 128: Report of Progress of Stream Measurements for the Calendar Year 1904. Prepared under the Direction of F. H. Newell, by M. R. Hall, E. Johnson, Jr., and John C. Hoyt. Part V.—Eastern Mississippi River Drainage. Pp. 168; two plates and one text illustration.

Some idea of the variety and magnitude of the work now being carried on by a single division of the U. S. Geological Survey may be gained from the foregoing list of Papers which have reached us within the past two months. Many others have also been noted in recent numbers of this Supplement. It will be seen that in some lines the papers have become so numerous as to require consolidated indexes.

Mr. Leighton is doing good service in collecting and classifying existing data and securing new data on the quality of the natural water supplies of the country. In Paper 108, on the Susquehanna River, he deals with the largest river on the Atlantic Slope, having a drainage area of about 27,400 square miles, and one that receives large quantities of acid mine wastes and culm. The river is also polluted with sewage. Analyses and other data bearing on these various sources of pollution are presented in the paper.

Twenty-three contributions too short for separate publication, written by 19 geologists, physicists and others, have been combined to make Paper 110. The first contribution is by Prof. Chas. S. Slichter, and, as he says in his opening sentence, is a more detailed account than the one published by him in Engineering News of Feb. 20, 1902, of his electrical method of measuring the velocities of underground waters. The account is well written and illustrated. Other contributions by Professor Slichter succeed the first, as follows: "The California or 'Stovepipe' Method of Well Construction," giving information in addition to the author's contribution to Engineering News of Nov. 19, 1903; and "Approximate Methods of Measuring the Yield of Flowing Wells." The latter consists mostly of tables compiled some years ago and privately circulated by Prof. J. E. Todd, State Geologist of South Dakota. Two pages of notes and diagrams on the same general subject are contributed by Prof. A. N. Talbot. There follows a description of studies of well contamination at Quitman, Ga., by Mr. S. W. McCallie, in which Professor Slichter's chlorine method of tracing underground streams was used. The next contribution describes the new artesian water supply of Ithaca, N. Y. The others deal with the water supply resources of various areas in the eastern part of the United States.

The "Underflow Tests in the Drainage Basin of the Los Angeles River" (No. 112), by Mr. Hamlin, describes another application of Professor Slichter's methods, with variations to meet local conditions. Some interesting details of well sinking are included in this paper.

Paper 114 opens with a general discussion of underground waters, written by Mr. Fuller, and is followed by contributions from some twenty geologists, covering the states east of the Mississippi and bordering that river on the west. The object of the various reports is "to meet the demands of drillers and others for information relating to the general water resources of the various States or of specified regions." The general plan followed for each State is to review its topography, geology and water resources, in some cases giving a tabular description of municipal water supplies and statistics of bottled spring waters, and then to append a list of publications bearing on the subject.

Nearly all the profiles and surveys reported in Paper 115 relate to rivers in Georgia. The text describes briefly rivers and corresponding surveys, and is supplemented by profiles and tables showing elevations. The general plan of the survey is described as follows:

> The elevations were based upon reliable heights derived from primary or precise levels of the United States Geological Survey. On this datum, with few exceptions, lines of flying levels were carried up the bank of each stream and bench marks were established at intervals of about 1 mile, usually on nails on tree roots. The elevations of the surface of the water at the head and foot of each shoal, rapid, or fall were noted. These levels, with few exceptions, have been tied at both ends. In the case of Broad River primary levels were used instead of flying levels, and regulation bronze tablets left at intervals of 6 miles.
>
> The horizontal control of the survey was by plane table oriented by compass, while the distance was always obtained by means of stadia measurements. To further insure the accuracy of the work, the stadia rod was so divided that one division on it equaled one division of the scale used in plotting.

The extension of these surveys and the publication of the results will be welcomed by engineers, manufacturers looking for water power, development companies and municipalities.

At the request of the city and county of Santa Barbara the topographic and hydrographic branches of the U. S. Geological Survey have carried out their respective lines of work for that section, the city contributing a considerable part of the expense of the report issued as Paper 116. Water sufficient for the municipal and irrigation needs of this section is so scarce in the vicinity that Mr. Lippincott recommends going beyond the mountains, building an impounding reservoir to hold the winter floods of the Santa Ynez River, and bringing water to the coast by means of a tunnel. Earlier studies of this general problem are reviewed, the present source is described and discussed and many stream and other records are given, including gagings of the yield of the present city water tunnel. A few choice half tones accompany the text.

Since irrigation in North Dakota is largely dependent upon water raised from the Missouri River by pumping, the possibilities of obtaining a cheap local fuel have very properly been made the subject of a paper (No. 117) in this series. The author discusses the distribution of lignite throughout the State and the amount mined in 1902, laboratory and practical tests of its fuel value and methods of burning. Three pages on "Pumping Water with Lignite," based on the use of centrifugal pumps, are contributed by Chas. S. Magowan.

The usual program for the papers on the geology and water resources of delimited areas is followed by Mr. Calkins in No. 118, dealing with the East-Central portion of Washington. Artesian and other wells are considered. Illustrated descriptions (about four pages) of apparatus for testing artesian pressure are reprinted from T. C. Chamberlain's "Requisite and Qualifying Conditions of Artesian Wells," which appeared in the Fifth Annual Report of the U. S. Geological Survey" (1885).

A large mass of information on the rainfall, run-off, stream heights and water power of numerous drainage areas is now to be found in the various monographs and reports of the Survey, and as this is scattered through so many volumes the hydrographic index (No. 119) will be of great service to those who wish to look up data for any stream.

Paper 120 is a convenient bibliography of the Survey publications on underground waters, and is made all the more useful by a detailed subject index and a classified key to the index.

Mr. Johnson's "Relation of Law to Underground Waters" (No. 122) first reviews common-law rules, with reference to judicial decisions, and then outlines the legislation of 15 States on the subject. The paper, it would seem, might well have been longer, but short as it is it will be welcome to many puzzled engineers, lawyers, public officials, land owners, and water-works and irrigation companies.

Papers, 124, 126, 127 and 128 are the first instalments of the latest annual review of stream measurements, which will be completed in twelve parts. Each Part or Paper has a separate index. The corresponding data for the year 1903 was printed in four Parts (Papers 97 to 100, inclusive), each covering more territory and forming much thicker volumes than these. The change will be a convenience to those interested in small sections of the country.

TRAITE COMPLET DE LA FABRICATION DES BIERES.—By G. Moreau and Lucien Lévy, Professors in the Ecole Nationale des Industries Agricoles de Douai. Paris: Ch. Béranger. Cloth; 6½ × 9¾ ins.; pp. 674; 5 plates, and 173 figures in the text. 25 fr.; American price, $7.50.

This comprehensive work deals with the principles of fermentation, and with the chemical features and practical processes of the manufacture of beer. A preface and introduction give some interesting historical and statistical facts relating to the subject in hand. From the latter it is learned that the three leading countries in the production of beer in the year 1903 were as follows: United States, 2,210 breweries and 74,260,000 hectoliters; Germany, 18,230 and 67,484,000; Great Britain, 5,547 and 58,104,605.

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Literary Magazines.

Of the articles of interest to engineers in the July literary magazines, first place must be awarded to the "Century" paper by Mr. Frank J. Sprague on the early history of the electric railway. He begins with the toy experiment by Thomas Davenport, the Vermont blacksmith, in 1834, and follows down the list of the scientists and inventors who experimented with electric cars and locomotives driven by current from primary batteries, all of whom reaped no reward for their ingenuity because until the invention of the dynamo no economical source of electric current was available. In the years from 1879 to 1887, following Gramme's epoch making invention of the dynamo, a large number of inventors and engineers were busily at work on the development of the electric railway; but it was not until the notable success achieved in 1887 and 1888 by Mr. Sprague on the Richmond, Va., street railways, which led to the adoption of electricity for the West-End System in Boston, that the active commercial exploitation of the electric railway began.

Mr. Sprague describes in graphic fashion the trials and struggles of these early inventors. Their progress was slow and discouraging until capitalists suddenly became convinced of the great future that lay before the new motive power, and poured in the funds that made success comparatively easy. Mr. Sprague is to follow this first paper with a second in the August number, describing in more detail the pioneer work at Richmond, and the progress in the art since 1887. A word of complimentary mention is also deserved here for the series of "Century" papers on the Associated Press and its work, written by its Manager, Melville E. Stone.

"What a City Might Be" is the title of a paper by M. G. Cunniff in the "World's Work" for July, in which are described some of the plans for beautifying American cities and some of the work already done in this field. "Better Conditions for Workers," in the same magazine, is a short but excellent review of recent improvements in factory construction and equipment.

In the "Review of Reviews" we find two interesting papers on the railway rate problem by two professors of the University of Wisconsin. Prof. W. D. Taylor, M. Am. Soc. C. E., defends the thesis that any combined effort of the railways to raise rates would, in the main, be against their own interests. Prof. John R. Commons discusses the new railway legislation in Wisconsin. In the same magazine, articles on "How Niagara is Harnessed," and a description of Argentina, by U. S. Minister John Barrett, deserve mention here.

Railway Bridge Floors.

PROTECTING AND WATERPROOFING SOLID BRIDGE FLOORS.—By W. C. Cushing, Chief Engineer of Maintenance of Way, Pennsylvania Lines (Southwest System). Bulletin No. 64 of the American Railway Engineering and Maintenance of Way Association. Chicago: The Association. Paper; 6 × 9 ins.; pp. 34; illustrated.

BALLASTED BRIDGE FLOORS.—By A. F. Robinson, Bridge Engineer, Atchison, Topeka & Santa Fe Ry. Chicago: Journal of the Western Society of Engineers. Paper; 6 × 9 ins.; pp. 46; illustrated. 50 cts.

The present tendency in railway bridge construction is to use solid floors in place of the open floor system which has for years been typical in American bridges. This tendency has received an impetus from the great number of bridges required for track elevation in various cities, where noiseless and waterproof properties are frequently imposed by the local authorities, but apart from this it is being recognized that solid floors are an advantage to the bridges themselves. The floors may or may not be ballasted, but the general practice is to use ballast, and this has many advantages. The two papers noted above contain a large amount of information as to various designs of floors and the results which have been obtained. Mr. Cushing's paper describes in detail floors used at different parts of the Chicago track elevation work of the Pennsylvania Lines, and especially the various methods tried for making these floors watertight by the use of cement concrete, asphaltic concrete, felt, etc. Mr. Robinson's paper describes and illustrates a remarkable variety of design, including steel troughs, transverse I-beams with steel or wooden deck, reinforced concrete etc., and these are supplemented by designs mentioned in the discussion which accompanies the paper. There is, however, no mention of the extended and successful use of asphaltic concrete for the filling of trough floors on the Chicago & Northwestern Ry., which was described in Engineering News of Nov. 12, 1903. Mr. Cushing considers that such concrete is not desirable, but in this he differs from the engineers of the railway mentioned. The two papers show the reasons for and the advantages of the use of solid floors, and also show the various styles of solid floors used on different railways.

BUREAU OF FORESTRY OF THE PHILIPPINE ISLANDS.—Report of the Chief for the Period from Sept. 1, 1903, to Aug. 31, 1904. Manila, P. I.: Pub. Doc. Paper; 6 × 9 ins.; pp. 68; 25 plates, and one folding map.

The work of the year here reviewed included some tests of native woods. The results of the tests are given in tabular form.

THE ENGINEERING REVIEW.—Published annually by the Engineering Society of Purdue University. No. 1, 1905. Lafayette, Ind.: The University. Paper; 6 × 9 ins.; pp. 94; illustrated. 50 cts.

Among the papers here printed are: "Superheated Steam in Locomotive Service," by Prof. W. F. M. Goss; "A Novel Blue Printing Apparatus," by H. O. Garman; "Framing of Passenger and Freight Cars," by C. A. Seley, Mechanical Engineer, Chicago, Rock Island & Pacific Ry.; "Further Tests of Concrete Beams," by Prof. W. Kendrick Hatt; and "Tests to Determine the Pressure in Locomotive Ash-Pans," by H. A. Johnson.

ASSOCIATION OF CIVIL ENGINEERS OF CORNELL UNIVERSITY.—Transactions, Vol. XIII., 1904-5. Containing Addresses by Non-Resident Lecturers, Miscellaneous Papers, and List of Members of the Association. Ithaca, N. Y.: The Association. Paper; 6 × 9½ ins.; pp. liv. + 112; folding and other plates, and text figures.

Of the dozen papers here printed we mention: "The Art of Writing Specifications that Will Secure Good Work at Fair Prices," by H. P. Gillette; "The Thebes Bridge," by Ralph Modjeski; "The Syra Valley Bridge at Plauen," by Herr Fleck; "Reinforced Concrete Structures for Railroads," by A. O. Cunningham.

RAILWAYS OF CAPE COLONY.—Report for the Six Months Ending June 30, 1904. Cape Town: The General Manager of Railways. Paper; 8½ × 13 ins.; pp. 316; map and diagrams.

The report of the General Manager, Mr. T. S. McEwen, occupies only 13 pages, the remainder of the volume being composed of reports of department officers, and the usual tabulated statistics. Portions of the lines have been double-tracked, in order to provide work for men out of employment, but "this labor has proved most expensive, as it is of a very poor class." The policy of boring for water has been continued, and experiments are to be made with the Mirrlees-Watson water softening process for boiler waters. The extension of "development" lines of cheap construction but of the standard gage (3 ft. 6 ins.) is recommended.

BRITISH STANDARD RAIL SECTIONS AND SPECIFICATIONS.—Reports of the Engineering Standards Committee: (1) Flat-bottomed or T-Rails; (2) Bull-headed rails. London: Crosby Lockwood & Son. New York: D. Van Nostrand Co. Two Reports. Paper; 8¼ × 13 ins.; pp. 10 (with 20 plates) and 9 (with 12 plates). American price, $1 each.

These standard sections and specifications are the outcome of a movement somewhat similar to the movement in this country which led to the general adoption of the sections recommended by the rail committee of the American Society of Civil Engineers. There are nine bull-head sections, 60 to 100 lbs. per yd.; and 17 T-rail sections, 20 to 100 lbs. per yd.

THE DESIGN OF CONCRETE-STEEL BEAMS.—By W. Noble Twelvetrees, M. I. Mech. E. (Reprinted from the Transactions of the Civil and Mechanical Engineers' Society). London, Eng.: The Society. Paper; 5½ × 8½ ins.; pp. 20; 17 figures in the text.

This is a short and simple exposition of a method for figuring the stresses in reinforced concrete beams. The author first states the constants safe to use in beam design and explains the function of the reinforcement. The calculation of beams is then taken up, considering first bending stresses, and then shearing stresses; a general discussion of floor design follows. The paper closes with descriptions of typical forms of beam design.

Ready About July 25th

BRIDGE AND STRUCTURAL DESIGN

BY

W. CHASE THOMPSON, M. Can. Soc. C. E.

THE ENGINEERING NEWS PUBLISHING CO.

220 BROADWAY, NEW YORK

MUNICIPAL OWNERSHIP OF STREET RAILWAYS.—With an Analysis of the Accounts of the City of Glasgow Tramways. By James Marwick, C. A., of Marwick, Mitchell & Co., 79 Wall St., New York (Reprinted from The Wall Street Journal of June 3, 1905). Paper; 5 × 7½ ins.; pp. 15.

Some comparisons between Glasgow street railway statistics and those for a few American cities are made and the general subject of municipal ownership is discussed in an unusually impartial manner. The author rightly praises the accounting system and published reports of the Glasgow tramways, but strongly disapproves the gradation of fares according to distance traveled. This, he believes, concentrates population. He would have uniform fares and extensions of the tramways so as to scatter population. Apparently the author does not sufficiently take into account the conditions surrounding railway extensions and graded rates of fare in British towns. The cities were closely built long before the tramways were built, and the graded fares follow the same practice in the case of omnibus lines. Moreover, the whole spirit of charges for service abroad, both public and private, is to make the payments correspond with the amount of service rendered, instead of following the American plan of a single high price to cover an unlimited service. Graded fares have some disadvantages, but it must be remembered that owing to the extreme conservatism of the people changes must be effected slowly in Great Britain.

Publications Received.

COKE.—A Treatise on the Manufacture of Coke and Other Prepared Fuels and the Saving of By-Products, with Special References to the Methods and Ovens Best Adapted to the Production of Good Coke from the Various American Coals. By John Fulton, M. Am. Inst. Min. E., Scranton, Pa.: International Textbook Co. Cloth; 6 × 9¼ ins.; pp. 476; tables, folding plates, and many text illustrations. $5.

MECHANICAL DRAWING.—Technique and Working Methods for Technical Students. By Charles L. Adams, Associate Professor of Drawing and Descriptive Geometry in the Massachusetts Institute of Technology. Boston: Geo. H. Ellis Co. Cloth; 8½ × 11¼ ins.; pp. 204; 23 plates, and 160 figures in the text.

NATIONAL ASSOCIATION OF MANUFACTURERS OF THE UNITED STATES OF AMERICA.—Proceedings of the Tenth Annual Convention, Held at Atlanta, Ga., May 16, 17 and 18, 1905. New York: The Association (Secretary's Office, 170 Broadway). Paper; 5¾ × 9 ins.; pp. 320.

NATIONAL ELECTRICAL CODE.—Rules and Requirements of the National Board of Fire Underwriters for the Installation of Electric Wiring and Apparatus, as Recommended by the Underwriters' National Electric Association. Edition of 1905. (Address, Underwriters' Laboratories, Chicago, Ill.) Paper; 3½ × 5½ ins.; pp. 139.

PRACTICAL PERSPECTIVE.—A Practical Explanation of the Only Practical Perspective (Isometric). By Frank Richards, Associate Editor "American Machinist," and Fred H. Colvin. New York: The Derry-Collard Co. Flexible cloth; 5½ × 8 ins.; pp. 50; 62 figures in the text. 50 cts.

RHODE ISLAND COMMISSIONER OF DAMS AND RESERVOIRS.—Annual Report to the Governor, January, 1905. Providence, R. I.: Pub. Doc. Paper; 6 × 9 ins.; pp. 29; folding diagrams and other illustrations.